Cement MILL SECTION of

Concrete

Vol. 20 MARCH, 1922 No. 3

The Plant and Process of the Eastern Potash Corporation

By R. Norris Shreve
Consulting Chemist, New York City

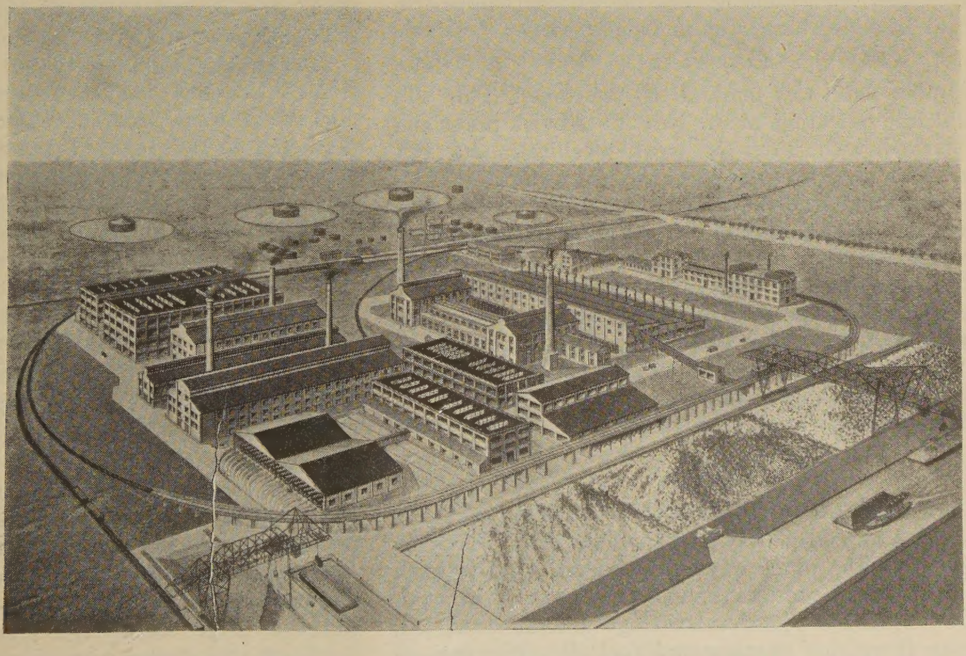
Americans have been notably lax in developing certain of their resources, and this has been true of even such an important industry as that pertaining to the supplying of potash for fertilizer and for chemical uses. For years we have imported very large tonnages of potash from Germany without giving serious thought to the development of our own potash resources. The war, however, woke us up in this respect, as it did in a great many other ways. We were forced to the conclusion that it is an almost primary consideration in our national policy that there be developed within our own domain all key industries, such as the potash industry, the dye and medicinal industry, and the like.

In case of potash, we did not develop our resources, due not only to the great ease of obtaining such supplies by simple importation, but also due to the apparent difficulty of extracting the potash from the sources lying dormant within our own boundaries. However, within the last five years a great many efforts have been made to commercialize these resources. Some of these, such as the development in Searle's Lake, Cal., and in the alkali region of Nebraska, have been very successful and have produced large tonnage of high grade commercial potash.

But so far there is no large potash undertaking that is in successful commercial operation in the Eastern section of the United States, where the large markets for potash exist. It has long been known that tremendous amounts of potash are in the greensands of New Jersey and of contiguous states, and as a matter of history these greensands were used very extensively by the farmers some fifty to seventy-five years ago for fertilizing their fields, at a time when labor was cheap.

For the past few years a company has operated an experimental plant at Jones Point, N. Y., where it has treated up to 20 tons a day of this New Jersey green-

Fig. 1 — Sketch of Completed Plant as It Will Appear When Completed



sand and has made potash compounds out of it. This company, namely Eastern Potash Corporation, now has nearing completion its large plant for the commercial manufacture of potash compounds out of greensand; this plant, with its subsidiary fuel company, occupies over a hundred acres of land on the Raritan river, near New Brunswick, N. J.

The process which was used at the experimental plant and is now being installed at the New Brunswick factory, involves the treatment of greensand with milk of lime, at the temperature of 500 lbs. steam (about 470° Fahr.), whereby the potash in the greensand is rendered soluble and whereby also the greensand unites with the lime to form a solid residue which possesses valuable cementitious properties.

GREENSAND

The main raw material is New Jersey greensand, which mineralogically is a mixture of glauconite with sand, clay or calcareous material. This greensand is an olive green or bluish green sandy material, which underlies the soil of hundreds of square miles of the state of New Jersey, and which also reaches down into Maryland and Virginia. The richer beds, lying in New Jersey, extend in a strip from the Atlantic Ocean at Atlantic Highlands and Long Branch in a southwesterly direction to the Delaware River, a point somewhat below Wilmington, Delaware.

This greensand is exposed to view in a great number of railroad and road cuts, and often where the creeks have washed into the soil. The overburden is in many cases only a few feet, and the material lends itself to modern mining methods such as steam shovel or hydraulic dredge.

In certain sections of New Jersey there are the grass covered pits from which, fifty years ago, when labor was cheap and no concentrated potash fertilizers were available, the farmers mined and spread this material on their fields. The use of the greensand directly by the farmers was not very advantageous, for the reason that the potash contained in it was only very slowly available, and it was driven out of the market by the easily soluble potash salts from Germany.

The Eastern Potash Corporation will use 1,000 tons per day of this New Jersey greensand, removing the potash by chemical means and marketing the potash compounds in the pure forms in which we have been accustomed to use them. The greensand will be shipped to the plant in either barges or in freight cars.

LIMESTONE

The other main raw material is limestone. This will be burnt into quicklime at the New Brunswick plant and then slacked with water or weak washings, and this milk of lime used to decompose the greensand.

The limestone needed will amount to about 1,800 tons per day, and will be brought down from the company's deposit at McAfee, Sussex county, New Jersey, by a short railroad haul of about 80 miles. The limestone at McAfee is the metaphoric variety and as a rule is a very pure material. The company's deposits amount to over 50,000,000 tons above the level of the railroad. This will be crushed at the quarry and shipped to the potash plant in a form ready to be burnt in the rotary kilns.

FUEL

In a plant of this size fuel is very important, as there will be used approximately 400 tons per day. Early in the design of the plant it was considered wise to burn oil, and in order to do this economically the company put in its own plant design for treating Mexican crude oil, obtaining therefrom gasoline and fuel oil. The fuel oil will be used for firing the lime kilns and generating steam at the potash plant.

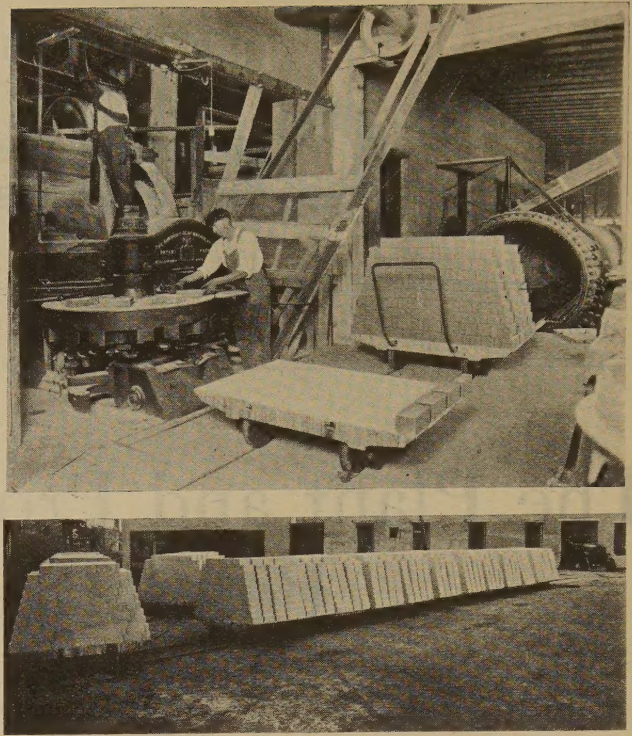


FIG. 2—BRICK MAKING AT EXPERIMENTAL PLANT AT JONES POINT

This fuel plant is now in full operation, treating on an average 4,000 bbls. of Mexican oil per day. The plan is to sell the gasoline made, but pending the completion of the potash plant the fuel oil is also being sold.

EXPERIMENTAL PLANT

In such an undertaking as this, whereby large tonnages of material must be economically handled, it is absolutely necessary to try out on a commercial size many of the various types of equipment necessary. Consequently an experimental plant was operated at Jones Point on the Hudson River, about 40 miles above New York City, and here different types of digestors were installed and operated, six different kinds of commercial filtering devices were tried out and studied, as well as various pumps, presses, mills, mixtures, etc. This plant was operated over two years, and approximately $300,000 were spent in this work.

During this time up to 20 tons of greensand were treated per day, and over certain periods continuous operations were secured. The potash was made and marketed in the form of caustic potash, and was sold to very discriminating customers. The cementitious material remaining after the extraction of the potash was manufactured principally into several million bricks, which were utilized in constructing two of the large buildings at the main plant at New Brunswick. This cementitious material produced here was also used successfully for stucco and for liming soils.

RARITAN PLANT—GENERAL FEATURES

The location of this plant is on the Raritan River, three miles below New Brunswick, and it is about midway between the limestone deposits on the north and greensand deposits on the south. By virtue of being on the Raritan River, it also possesses cheap water transportation to the markets of New York and vicinity.

The general problems at this plant are very largely engineering, in order to economically take care of the heavy tonnages of materials that must be handled. To facilitate this matter, there already has been dug a canal

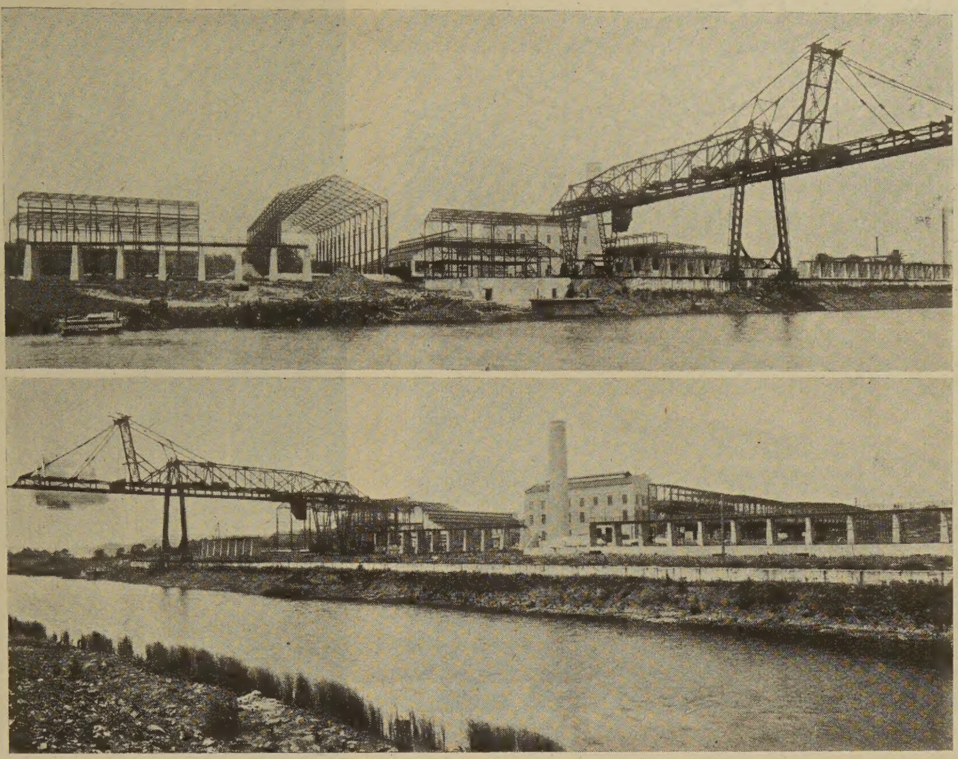


Fig. 3—Canal, Gantry Crane, Power House and Adjoining Buildings

connecting at both ends to the Raritan River, and a very large crane has been installed and extensive railroad tracks have been built. The crane is a 10-ton Gantry type, and operates on its own tracks paralleling the canal, the railroad track and the main raw material buildings. Thus the crane will be able to unload the barges and transport the material either to storage against transportation delays, or to the buildings. It will also be able to handle the lime rock which enters the plant by railroad, transferring it to storage, or from storage back to the limekiln building.

The amount of water that will be necessary for use in the condensers of the evaporating plant and for other uses throughout the factory will be very large, amounting to over 30,000,000 gals. per 24 hours. This will be supplied by two centrifugal pumps of the Rees Roturbo make, manufactured by the Manistee Iron Works, Manistee, Michigan, and each pump will have a 30-in. suction and will be driven by a 300 h. p. motor.

The main power plant consists of three 1,200 nominal h. p. Sterling water tube boilers manufactured by Babcock & Wilcox, operating at 220 lbs. pressure and 100° superheat. These boilers supply steam to three 1,500 kilowatt General Electric turbo generators. These turbines discharge their steam at 10 lbs. pressure for evaporating purposes in the large quadruple effect evaporating unit.

All in all, the plant has been designed from the very start with the idea of economic operation, due to the elimination of excess labor and installation of various devices which would secure continuous and cheap transportation and handling of the materials from the time they enter the plant until they are sold.

Lime Plant

The lime burning plant is the largest in the world, and was designed by Richard K. Meade. It consists of 10 rotary kilns, 8 ft. in diameter by 125 ft. long, built by the Vulcan Iron Works. The kilns are to be fired by oil. The waste gases therefrom, after passing through dust chambers, are to be conducted to the Sterling boilers, where these gases will be supplemented somewhat by the burning of fresh oil, thus supplying the heat necessary for the generation of the steam or power and evaporation purposes. The Vulcan kilns are fed with crushed limestone from storage hoppers, which are in turn supplied by a belt conveyor from the car dump or from storage.

The limestone, after having been burnt in kilns, drops down into the coolers, 5 ft. in diameter by 50 ft. long, made by the Worthington Pump and Machinery Corporation. These in turn discharge the partly cooled lime into the slackers, where the lime is mixed with about three times its weight of water or weak washings from the filtration plant. This hot milk of lime is now pumped to the greensand building of the potash plant, where it is properly proportioned and mixed with the ground greensand preparatory for conversion of the potash into soluble form.

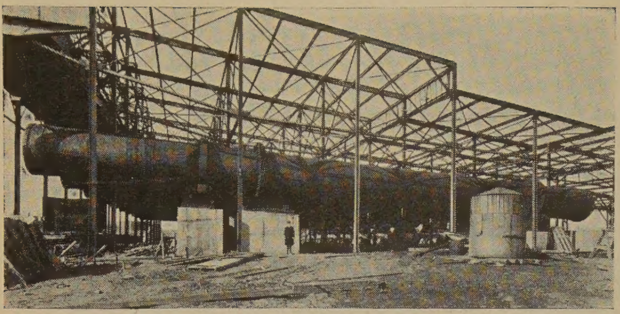
Due to economies that have been worked out in the potash recovery, it is quite likely that the lime plant will have sufficient capacity so that approximately 100 tons per day can be sold as such, probably in the form of slaked lime.

Potash Plant and General Operations

While the greensand is received from the mines in a granular sandy condition, yet it must be ground so that approximately 90% will pass a 200 mesh, in order to secure the most economic conversion. The reason for this is apparent when one remembers that greensand is practically insoluble and that consequently for the lime to act efficiently the greensand must be in finely divided state, so as to expose a large part of its mass to the action of the chemicals. This grinding will be done in tube mills. The ground greensand pulp is then pumped to storage, and measuring tanks, where it is proportioned with the milk of lime in the ratio of:

Greensand	1,000 tons per day
Quicklime	900 tons per day
Water	5,000 tons per day

This mixture is now known as slurry and it is ready for pumping through the digestors.



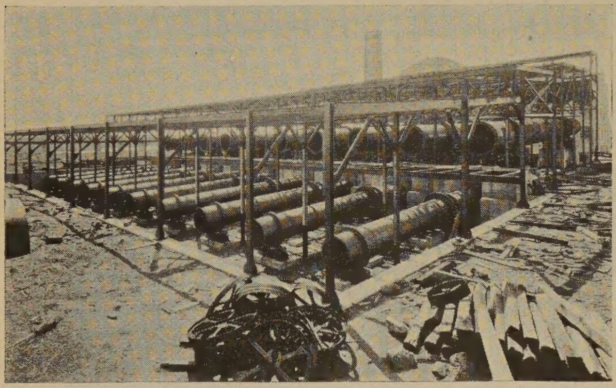
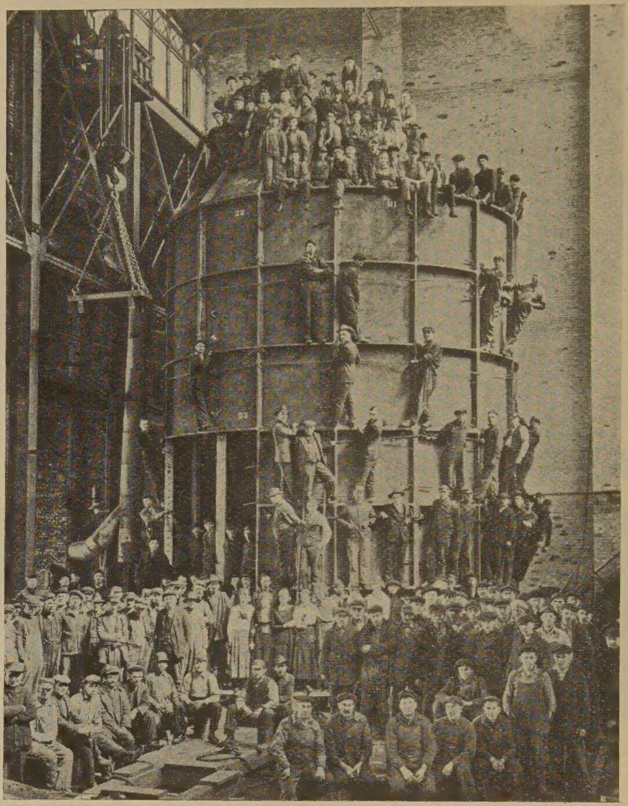


Fig. 4—Largest Lime Burning Plant in the World, Under Construction



The main reaction will go on in continuous digestors, which are to be 28 in number, and which will consist of large pipe of sufficient length to hold the slurry therein for about one hour from the time it enters until it leaves. Before entering the digestors the slurry is heated up to a temperature of about 470° F. by having injected into it steam at 550 lbs. pressure. In order to facilitate the reaction the slurry must not only be hot, but must have its water kept in the liquid phase. To attain this latter condition, the pressure on the slurry must be higher than that corresponding to the steam pressure of water at its temperature. This amounts to about 600 lbs. pressure, allowing a margin for safety.

To secure this pressure there are now being constructed four 12-stage centrifugal pumps, which will take the mixed slurry and raise it to 600 lbs. pressure before injection into the digestors. These pumps are being built by the Manistee Iron Works. An interesting feature of them is the device for lubrication, which consists of an exactly similar pump of very much smaller size, which pumps water into the bearings of the large pumps. This water is taken off at various stages of the lubricating pump, and led to the same stage of the main pump, thereby securing a lubrication at the various bearings of the main pumps through the agency of water at a slightly higher pressure than that prevailing on the working side of the bearing. This is necessary when it is remembered that the material being pumped is abrasive.

After the slurry leaves the digestors it is cooled in boilers, where the slurry takes the place of the hot gases

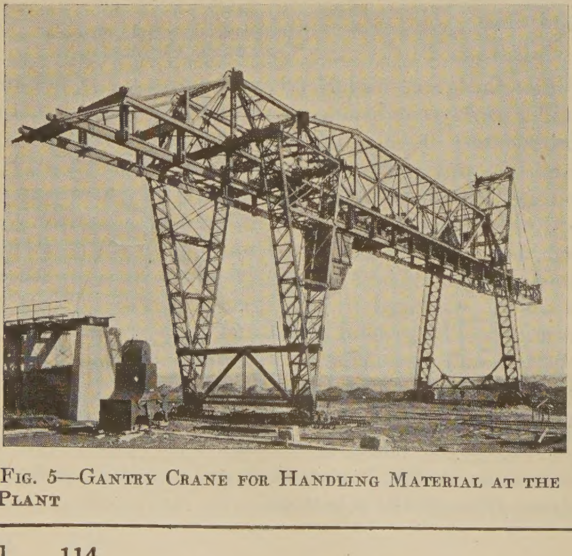


Fig. 5—Gantry Crane for Handling Material at the Plant

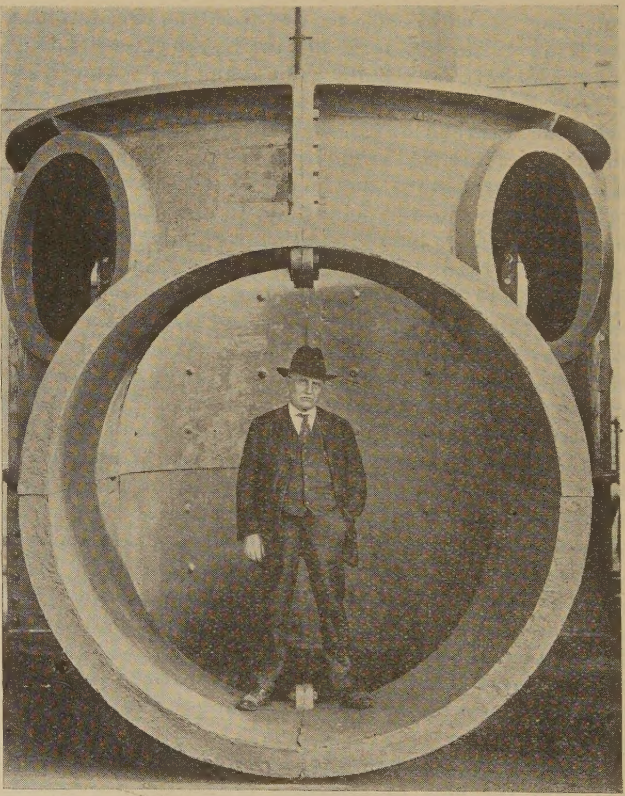


Fig. 6—Parts of the Large Evaporating Plant

and generates low pressure steam. These boilers are known as slurry boilers, consist of small tubes inside of large ones, arranged on the counter-current principle. It will be remembered that a very heavy pressure was given to the slurry before entering the digestors. It is necessary to offer a resistance to the passage of the slurry in order to be able to maintain this pressure, and another function of the small tubes of the slurry boiler is besides extracting the heat from the digestor, to offer this necessary resistance.

After leaving the slurry boilers, the hot digested slurry is to be conducted to the filter press, where the solids are separated from the liquids and where the solid or residue is washed free from soluble potash.

The potash liquors are then to be evaporated and solidified. Here the caustic liquors, containing 1—2% caustic potash, are concentrated first in large quadruple effect evaporators, up to about 40° or 45° Baume, and then in oil fired cast iron caustic pots up to 88% to 92% caustic potash. This latter, upon cooling, is the ordinary solid caustic potash of commerce.

The construction of the evaporator plant is mostly completed. This consists of four evaporators of the Manistee type, made by the Manistee Iron Works, of Manistee, Michigan. They are composed of cast iron segments bolted together and are about 22 ft. inside diameter by about 50 ft. high over all. Each evaporator contains over 3,000 tubes, 12 ft. long by 2½ in. in diameter. The condenser is of a surface type in order to conserve the distilled water. This evaporating plant is capable of concentrating off 5,000 tons of water from the weak caustic liquors.

BRICK PLANT

Returning to the filtration step, it will be recalled that the dilute caustic potash was washed out of the solids remaining after the action of the lime on the greensand. This solid or "residue" as it is named, possesses valuable cementitious properties, and forms the basis for excellent bricks. In fact, several million of these brick have been used to date in the construction work at the plant. The accompanying illustrations show several of the buildings in which these brick were used. The tests on these bricks, according to the various building codes, indicate that they are a very high class product.

Plans are now being drawn for a plant to make 500,000 brick a day out of this residue. The process is simple, and involves the mixing of one part of the cementitious "residue" with about three or four parts of sand, molding and pressing into bricks and hardening in steam cylinders. The action is not just the same as takes place in the manufacture of sand lime brick, where lime alone acts to harden the mixture of sand and lime in a steam cylinder, for the residue, while it carries some 40% of total lime (as CaO) yet has only a small part of this lime present as calcium hydroxide. The major part of the lime in the form of calcium silicates possess cementitious properties.

OTHER USES FOR RESIDUE

Carrying as it does over 40% of lime (as CaO), it was thought that this residue would be of considerable value in the sweeting or liming sour soils. Accordingly, experimentation was started, with the co-operation of the New Jersey Experimentation Station at New Brunswick, using this lime carrying residue or "Limosil," as it is called when applied to soils.

While there has only been time for growing two crops on the same soil, yet the results to date show that the Limosil is very valuable for increasing the crops grown on many soils. Such actual trials are being continued and extended to various rotations and to different types of soils.

The residue also has been successfully applied as stucco, and the tests have now withstood two winters in rather an exposed location.

SUMMARY

The Eastern Potash Corporation is constructing near New Brunswick, N. J., a large plant to make potash, bricks, soil liming material, etc., out of New Jersey greensand by treatment with milk of lime at 470° Fahr., and under sufficient pressure to keep the water in the liquid phase.

The fact that all raw materials will be turned into useful products, and the great engineering care taken to economize heat and the handling of the large tonnages involved, are the outstanding features of the plant.

Dissolution of Cement Securities Asked

The government asks that the Cement Securities Co. be dissolved under the supervision of the U. S. Court at Denver, into such a number of separate and independent units of different ownership and control as may be deemed necessary to restore competitive conditions in the manufacture and sale of portland cement in the so-called Rocky Mountain region of the United States, and that pending such dissolution the company and its agents be enjoined from voting or receiving dividends upon the stocks of the several manufacturing corporations acquired by it in pursuance of its alleged unlawful purpose.

In commenting upon this suit, Attorney General Daugherty pointed out that it is one of a series of proceedings instituted under the Sherman anti-trust law with a view to restoring competitive conditions in the cement industry in this country. The Cement Securities Co. neither manufactures nor sells cement—it is strictly a holding company, and it is alleged by the government that it constitutes a monopoly of the type which was condemned by the United States Supreme Court in the so-called Northern Securities Case, decided in March, 1904.

In the cases previously instituted at New York City, Chicago, and Kansas City the defendants are charged with accomplishing their alleged unlawful objects by the modern method of so-called open price associations and the exchange between members of comprehensive statistical data with respect to the business of each. The exchange of statistical data between potential competitors likewise was condemned by the United States Supreme Court in is recent decision against the American Hardwood Lumber Manufacturers Association.

The Attorney-General has failed to agree with Herbert Hoover, Secretary of Commerce, with respect to the latitude that should be given trade associations.

"Naturally, it is the desire of the Department of Commerce," he said, "to give to the business public the most accurate information regarding these trade associations that is possible. The Department of Justice would not interfere in this plan but for the fact that we have prosecutions and proceedings pending all over the country. We ought to encourage and perpetuate the organization of these associations that are doing a legitimate service for business, but we cannot be accommodating in making concessions to these organizations when such concessions weaken or abandon the rule laid down in the recent beneficial opinion of the United States Supreme Court in the American Hardwood case.

Kiln Efficiency Discussed

By C. O. Sandstrum
Chief Engineer, Hunt Engineering Co.
Kansas City, Mo.

If progress were dependent upon individual research and effort, the race would still be in the trees. This statement by Mr. Sandstrum at the end of this article expresses a lot of truth in a few words.

The sentiment expressed by the operator who "did not propose to disseminate the knowledge gained at the expenditure of much trouble and considerable expense" fortunately is not met with in the cement field as frequently as it was even a few years ago.

A man can not lift himself by his own boot straps but he can build up a foundation piece by piece and rise with it. Two individuals co-operating can make better progress than if working independently and a larger number working in unison, with a definite aim will accomplish results that would otherwise come more slowly if at all.

By helping the industry with which a man is connected, he helps himself.—Editor.

Quite frequently one is met by the idea that gases, because of the differences in their specific gravities, stratify, or separate into layers, the heaviest at the bottom and the lightest on top, after the manner of some liquids. Engineers who have made the requisite study of physics sometimes give voice to such impressions in spite of the fact that the kinetic theory, and the diffusive properties of gases are studied in all engineering courses.

Were gases to stratify according to the differences in their specific gravities, there would be (neglecting gases of trace quantities) a layer of carbon-dioxide next the earth, then a layer of argon, then oxygen and last nitrogen. Animal life as now constituted would soon perish under such a condition.

In the December number of Concrete, Messrs. Larmour and Stevenson describe a raw material preheater, or kiln economizer, built after the fashion of a closed feedwater heater. In arriving at the equivalent kiln capacity of this device, it was assumed that "the large volume of carbon dioxide, being heavy, lies in the bottom of the kiln, and acts as an insulating medium between the gases and the compound."

Of course, no such action as described above takes place. The carbon dioxide is thoroughly diffused as soon as produced. Situations apparently to the contrary are deep wells and mine workings, where the gas is evolved faster than can be diffused from the comparatively small surface of diffusion.

Following the sentence quoted in the foregoing is this: "Consequently the main heat transfer is accomplished by heating the bricks, and they in turn heating the compound." I think this is a mistake. That there is heat transfer between kiln lining and material in the upper half of the kiln is true, but in the passage down the kiln the material absorbs heat rapidly and in the lower half it is more likely to approach the temperature of the gases than of the lining doing so, because the lining is constantly losing heat by radiation and convection from the shell, while the material is constantly receiving heat, and any transfer must be *to* the lining. Furthermore, the material, as stated, is constantly receiving heat, while a unit area of the kiln lining receives heat during only two-thirds of the revolution of the kiln; this because of the insulating effect of the cement materials, which cover about one-third the periphery.

Another statement that does not conform with facts is, "The capacity of a kiln is proportional to its length, and also proportional to the square of the diameter. Hence, an increase in length will increase the output with the same fuel economy, or will give better fuel economy for the same output."

The idea that the capacities of kilns very as the *squares* of the diameters, springs from the knowledge that the area of circles vary as the squares of the diameters. The cross-sectional area, however, does not enter into kiln capacities because the cement material does not *fill* the cross-section. It is not the volume of the material but the surface area exposed to the action of the hot gases that determines the capacity of a kiln, therefore, the capacities of kilns vary directly as the diameters. Even this does not strictly apply for the reason that a body receiving heat is limited by its ability to absorb heat, and by the maintainance of the temperature of the hot fluid, and not by the *volume* of the hot fluid. The streams or filaments, of hot gases at a distance from the cold body are hampered by the resistance to conduction of the nearer filaments and by the operation of the law of radiation which states that the intensity of heat varies as the square of the distance from the source.

It is possible to make a concrete example of the rule quoted by comparing capacities of kilns of various sizes. Let us take the 6′ and 7′ x 80′ kiln in the table accompanying the article under discussion. The capacity stated is 16 barrels an hour or 384 barrels a day. Let us assume that the kiln has a uniform diameter of 7 feet and that the kilns used in our example have 9 inch linings, also that the raw material is what might be termed "average." Then if it is true that kiln capacities vary as the lengths, and as the squares of the diameters, the capacity of an 8′ x 125′ kiln would be

$$384 \text{ x } \frac{125}{80} \text{ x } \frac{6.5^2}{5.5^2} = 838 \text{ barrels a day.}$$

I don't believe that an 8′ x 125′ kiln will give such an output. Even by using the first power of the diameters, the kiln capacity becomes 710 barrels, which is only attained with the best of materials and under the most favorable conditions.

Everybody that has had to do with the operation of cement plants has given thought to the heat lost with the stack gases. The man with the short kiln deplores the fact; and the man with the longer kiln finds that his stack temperatures are still much higher than draft would require. In some plants waste-heat steam-boilers have been installed; and according to published costs, fixed charges have not always been given the consideration to which they are entitled. Messrs. Larmour and Stevenson have designed a preheater that may justify its cost but the tubes should be much smaller, and, of course, of greater number. Also, the draft loss imposed by this device will probably call for the use of an exhauster.

Stating the capacity of this heater in terms of kiln length is wrong because of failure to credit the kiln with the effect of radiant heat. In steam-boiler practice it has been well established that the surface exposed to radiation is many times more effective than the surface receiving heat by conduction. Again, it is assumed that because the gases passing through the pre-heater travel at a lower velocity than through the kiln, that they give up a correspondingly greater amount of heat. This is wrong as has been established in tests with heat-transfer apparatus. Heat transfer seems to vary as the square-root of the velocities of the fluids, therefore, the greater the velocity (practical velocity) the greater the rate of heat transfer, this because of "surface film" effect.

A kiln length sufficient to keep stack temperature down to the needs of draft would probably present mechanical difficulities that would be incommensurate with the advantage gained. There should be no serious obstacle, however, to "compounding," or "staging," kilns. It should be possible to connect two short kilns, with an air-seal at the connection, and which would give the same capacity and the same thermal efficiency as a single kiln of equivalent length, and which would have the advantage of separate control of the combustion and clinkering zones, and the calcining and preheating zones. Whether or not this control would be a great advantage I cannot say, not possessing exact information on which of the several functions limit kiln capacity. Such an arrangement would give the same flexibility as separate preliminary and finish-grinding units, and may increase capacity and economy by permitting us to favor one or other of the two "stages."

Most existing plants would present serious difficulties to "staging" kilns in the manner suggested, but nearly all plants would lend themselves to placing the additional kiln in prolongation of the present kiln, or at right-angles to it, with the discharge-end entering the stack-housing of the present kiln. Air seals may be used on both kilns should the air intake be a serious menace to draft.

On the subject of air-seals—I wonder if power tests with air-seal on, and with it off, would not disclose that the power cost is greater than the extra height of stack necessary to compensate for the drop in draft intensity caused by the air intake. This question was asked a mill operator who had taken off his air seals, but the questioner was informed in a roundabout, equivocating, evasive way, that he (the operator) did not propose to disseminate the knowledge gained at the expenditure of much trouble and considerable expense. Of course any such fellow is a back-tracker. It might be asked with propriety where he got the larger part of his information. If progress were dependent upon individual research and effort, the race would still be in the trees.

Production of Lime in 1921

Preliminary Report by the United States Geological Survey

About 2,531,000 short tons of lime, valued at $24,536,000, was sold in the United States, including Hawaii and Porto Rico, in 1921, according to an estimate made by the United States Geological Survey, Department of the Interior, from reports made by the principal producers. This quantity is less than that sold in any year since the Survey has collected its statistics, and is 29% less than that sold in 1920. The average value per ton in 1921 is estimated at $9.69. In 1920 it was $10.52, and in 1919 it was $8.84. Of the 42 states and territories that produced lime in 1921, five increased and twenty-seven decreased their output as compared with 1920. The five states that increased their output in 1921 made only small gains, and were affected by local or special conditions, such as contracts made late in 1920.

The sales of hydrated lime in the United States in 1921 were estimated at 737,000 short tons, a decrease of less than 14% as compared with those in 1920, whereas the sales of quicklime (including refractory lime or dead-burned dolomite) were estimated at 34% less than in 1920. Of the 30 states that reported an output of hydrated lime in 1921, only seven showed an increase in production. The estimated value of the hydrated lime sold in 1921 was $7,673,000, an average value per ton of $10.41. The average value per ton in 1920 was $10.89.

The accompanying tables show the estimated quantity and value of hydrated lime and total lime sold in states reporting sales of more than 18,000 tons, and the distribution by districts. The final figures for 1920 are given for comparison. With the exception of Michigan and the district represented by Illinois, Indiana, and eastern Missouri, the districts covered by the New England states, and the Middle Atlantic states, showed the greatest decrease in output. Firms that shipped building lime to Boston and New York reported that the demand in 1921 was greater in New York than in Boston.

Economic Conditions

Reports showed that fewer plants were in operation in 1921 than in 1920, and some firms that intended to start work either abandoned their intentions or held them in abeyance. Many small kilns on farms were not operated, on account of the high price of coal. Firms that actively operated plants for many years closed them down in 1921 because they could see no profit in the business. A few new plants were put in operation, although many of the old ones were active during only a part of the year. There was less complaint of shortage of labor in 1921 than for several years past. The high price of coal was still a drawback to the industry, but the cost of production was generally reported to be less than in 1920. High freight rates affected the production of lime to a great extent by closing markets to firms whose output could not all be taken in the local market and by raising the gross price so high that the potential consumer could not afford to pay it. The lime market was very poor and irregular until fall, when the demand apparently increased, but was still below normal.

Prices were unstable during the year, but on the whole decreased throughout the country. In one locality the average price of quicklime per ton from January to June was $9.80, and from July through November $7.30. The average price of hydrated lime per ton in the same locality was reported at $12.30 from January to June and $9.80 from July through November.

Construction Lime

Though a few producers reported that the demand for construction lime in 1921 was equal to or greater than in 1920, by far the larger number reported a much

LIME PRODUCED IN THE UNITED STATES IN 1920 AND 1921.

STATE.	1920				1921 (estimate)				Percentage of Increase or decrease in 1921.	
	Hydrated lime. (short tons).	Total lime.		Average value per ton.	Hydrated lime (short tons).	Total lime.		Average value per ton.	Hydrated.	Total lime.
		Quantity (short tons).	Value.			Quantity (short tons).	Value.			
Ohio	321,570	558,892	$6,238,908	$11.16	326,000	500,000	$5,050,000	$10.10	+ 6.4	- 10.5
Pennsylvania	169,639	784,083	7,519,147	9.59	131,000	473,000	4,180,000	8.84	- 22.8	- 39.7
Virginia	(a)	256,568	2,201,724	8.58	11,000	164,000	1,122,000	7.45	---	- 36.1
Missouri	51,987	209,113	2,319,285	11.09	42,300	153,200	1,553,000	10.14	- 18.6	- 26.7
Wisconsin	31,719	144,590	1,539,027	10.64	(a)	126,000	1,121,000	8.90	---	- 12.9
Massachusetts	4,699	129,108	1,753,110	13.58	3,900	117,000	1,447,000	12.37	- 17.0	- 9.4
Alabama	8,491	151,595	1,175,518	7.75	2,200	112,500	738,000	6.56	- 74.1	- 25.8
West Virginia	55,807	193,490	1,813,666	9.37	37,000	101,500	827,000	8.15	- 33.7	- 47.5
Tennessee	29,525	119,034	1,098,603	9.23	25,000	96,000	780,000	8.13	- 15.3	- 19.4
Indiana	37,997	134,672	1,348,819	10.02	28,800	88,700	837,000	9.44	- 24.2	- 34.1
Maine	(a)	101,503	1,495,625	14.73	(a)	87,500	1,127,800	12.89	- 21.2	- 13.8
New York	(a)	92,357	1,047,261	11.34	(a)	62,500	667,000	10.67	- 11.4	- 32.3
Maryland	38,422	100,914	951,588	9.43	28,000	60,000	538,000	8.97	- 27.1	- 40.5
Illinois	(a)	87,903	982,743	11.18	(a)	57,500	612,600	10.65	- 22.7	- 34.6
Michigan	(a)	140,813	1,386,760	9.85	(a)	50,000	450,000	9.00	- 42.1	- 64.5
Texas	22,116	56,489	569,135	10.08	19,400	44,000	467,000	10.61	- 12.3	- 21.0
California	(a)	48,571	653,075	13.45	(a)	43,300	574,500	13.27	- 66.9	- 10.9
Vermont	(a)	50,192	716,137	14.27	(a)	33,500	418,000	12.48	- .2	- 33.3
Connecticut	(a)	(a)	(a)	14.32	(a)	(a)	(a)	14.06	- 1.8	- 45.3
Minnesota	(a)	30,120	356,906	11.85	(a)	24,800	258,000	10.40	+ 61.6	- 17.7
Washington	(a)	31,033	324,042	10.44	(a)	18,000	222,000	12.33	- 25.2	- 42.0
Undistributed	81,144	149,101	2,052,761	-----	82,400	118,000	1,546,100	-----	----	----
Total	853,116	3,570,141	37,543,840	10.52	737,000	2,531,000	24,536,000	9.69	- 13 6	- 29.1

(a) Included in Undistributed.

LIME. PRODUCED IN THE UNITED STATES BY DISTRICTS IN 1920 AND 1921.

Districts.	1920			1921 (estimate)				Percentage of Increase or decrease 1921.	
	Hydrated lime, (short tons).	Total lime.		Hydrated lime (short tons).	Total lime.		Average value per ton.	Hydrated.	Total lime.
		Quantity (short tons).	Value.		Quantity (short tons).	Value.			
Connecticut, Maine, Massachusetts, New York, (eastern), Rhode Island, Vermont	29,082	409,742	$5,611,343	25,900	317,000	$3,937,400	$12.42	- 1.1	- 22.6
Maryland, New Jersey, Pa. (eastern), West Virginia (eastern)	246,641	887,046	8,551,273	172,160	517,300	4,530,000	8.76	- 30.2	- 41.7
New York (western) Pennsylvania (western), West Virginia (western).	24,722	213,417	1,957,063	30,000	132,500	1,164,000	8.78	+ 21.3	- 37.9
Virginia and North Carolina (a)	(b)	256,568	2,201,724	11,000	164,000	1,222,000	7.45	---	- 36.1
Ohio	321,570	558,892	6,238,908	326,000	500,000	5,050,000	10.10	+ 1.4	- 10.5
Michigan	(b)	140,813	1,386,760	(b)	50,000	450,000	9.00	- 42.1	- 64.5
Illinois, Indiana, Missouri (eastern)	83,813	355,344	3,770,222	64,900	233,800	2,317,600	9.91	- 22.6	- 34.2
Wisconsin	31,719	144,590	1,539,027	(b)	126,000	1,121,000	8.90	---	- 12.9
South Dakota, Minnesota, Iowa	3,269	42,816	496,088	4,300	35,500	361,000	10.17	+ 31.5	- 17.1
Alabama, Florida, Georgia, Kentucky, Tennessee	42,404	283,033	2,449,582	35,560	224,800	1,677,800	7.46	- 16.1	- 20.5
Arkansas, Colorado, Kansas, Missouri (western) Oklahoma, Wyoming	(b)	92,575	1,074,248	(b)	79,600	832,000	10.45	---	- 14.0
New Mexico and Texas	22,116	59,523	603,815	19,400	46,400	493,000	10.63	- 12.3	- 22.0
Arizona, California, Idaho, Montana, Nevada, Oregon, Utah, Washington	13,569	114,270	1,474,492	11,700	92,700	1,233,200	13.30	- 13.7	- 18.9
Undistributed	34,211	11,512	189,275	36,080	11,400	147,000	---	---	---
	853,116	3,570,141	37,543,840	737,000	2,531,000	24,536,000	9.69	- 13.6	- 29.1

(a) Virginia only; North Carolina is included under "Undistributed". (b) Included under "Undistributed."

smaller demand and a decrease of output of 20% to 75%. The total output of construction lime undoubtedly decreased in 1921, but that of chemical lime and agricultural lime decreased as much if not more. The output of Ohio, the state that produces the largest quantity of building lime (60% of the total), decreased only 10.5% in 1921, whereas that of Pennsylvania, 80% of whose output is sold as chemical and agricultural lime, decreased nearly 40%. This large decrease reduced Pennsylvania for the first time to second place among the lime-producing states. In spite of adverse conditions, a certain amount of construction work is always carried on throughout the country, and if the rates of transportation are lowered this branch of the industry will surely regain its pre-war position.

CHEMICAL LIME

The reports received indicate a very large decrease in the output of chemical lime in 1921, due to the decline and depression in the metallurgical and chemical industries. The production of dead-burned dolomite, which has replaced calcined magnesite for use in patching and lining basic open-hearth furnaces, decreased from 316,000 tons in 1920 to 140,000 tons in 1921. Decreases of 25% to 65% were reported for the plants that produce dead-burned dolomite. Decreases were also reported by plants that manufacture lime for use by paper mills, sugar factories, alkali works, carbide plants, and other chemical industries.

AGRICULTURAL LIME

A few producers reported increased sales of lime intended for use as fertilizer. Others reported decreases of 20% to 90%. Some producers reported that farmers were buying more lime because of the high price of other fertilizers. Others, however, reported that farmers were not buying but were waiting for a decrease in freight rates that would lower prices. Practically all producers reported that prices of lime at the kilns were lower in 1921 than in 1920.

The New England Lime Co., whose plant in Danbury, Conn., near New Milford, was recently destroyed by fire with a loss of approximately $200,000, is to rebuild immediately, according to a local report. The company is at work clearing away the debris of the fire and as soon as completed, will commence the erection of a new plant on the former site.

Some New Features in Limekiln Construction[1]

By Richard K. Meade

It is not the purpose of the present paper to present any very logical treatment of the subject of lime burning, but rather to touch on some points of limekiln design which are an improvement over common practice, and it is assumed that the reader is familiar with the general proposition of lime burning in both shaft and rotary kilns.

As a preliminary to the discussion of various improvements to be desired in a lime kiln, it may be well to give a short summary of what takes place in the burning of lime. We have in limestone calcium carbonate and magnesium carbonate, mixed with certain other chemical compounds as impurities, such as silica, iron oxide, alumina, etc. When limestone is burned, the carbon dioxide passes off, and lime and magnesia remain to form commercial lime.

To decompose calcium carbonate into lime and carbon dioxide, there will be required 1,451 B. T. U. per lb. of lime formed. To decompose magnesium carbonate into magnesia and carbon dioxide, there will be required 1,318 B. T. U. per lb. of magnesia. Hence, to burn dolomitic lime containing 54% lime and 46% magnesia there will be required 1,380 B. T. U. This explains why a magnesian lime can be burned more easily than a high calcium lime.

In designing a limekiln our object is to build a furnace in which the latent heat of the fuel is put to work to decompose the limestone. This is usually done by burning the fuel and passing the products of combustion through a body of the stone.

In the case of the flame kiln, the transfer of heat from the gases to the stone takes place in the shaft of the kiln. It is not practical to transfer all of the heat from the gases to the limestone, and some of it is always carried out by the gases. Manifestly, as the transfer of heat goes on the gases are cooled; consequently the temperature of the gases when they leave the kiln is an indication of the thoroughness with which this transfer takes place. Usually the gases pass through the arches at from 2000° to 2500° F. and leave the top of the kiln at from 400° to 700° F.

As the heat is transferred to the stone, the temperature of the latter increases gradually until a temperature of 1650° is reached, when no further increase of temperature occurs until the limestone has been completely converted to lime, when the temperature again rises.

Sources of Heat Loss

Incomplete Combustion of Fuel—In order to bring about this transfer of heat most economically, the coal must, of course, first be completely burned. Two common losses which occur are from the unburned coal carried out of the furnace in the ashes and from the carbon only half burned, to form carbon monoxide instead of carbon dioxide.[2]

Heat Carried Off By Gases.—It is well known that the rate of heat transfer is proportional to the difference between the gases and the material to be heated, other conditions remaining constant. Hence the gases entering the shaft should be at as high a temperature as is possible, consistently with the production of lime of proper quality. The greatest factor in determining the temperature of the products of combustion is the amount of air used for combustion. Thus, if we burn 1 lb. of coal with just the quantity of air necessary for combustion, the gases produced will weigh about 11 lbs. If we use twice as much air as is necessary, the products will weigh 21 lbs., etc. Now, manifestly, if we transfer the heat of 1 lb. of coal to 11 lbs. of gas the temperature of the latter will be much higher than if we transfer this quantity of heat to 21 lbs. of gas.

There is another objection to excess air. Some heat is always carried away by the gases leaving the kiln. This heat is proportional to the quantity and temperature of the gases. Eleven pounds of gas leaving the kiln at 400° will carry off only about one-half of the heat which would be carried off by 21 lbs. Similarly, 11 lbs. of gas leaving at 400° F. will carry off only about one-half the heat which it would at 730° F.

To promote kiln efficiency, therefore, we must cut down to a minimum the excess air used for combustion. Some excess is found necessary in practice, but holes in the fire bed, and the entrance of air during stoking, etc., are to be avoided.

Radiation.—Another source of loss of heat is that lost by radiation from the kiln shell.

Heat Carried Off By Hot Lime.—The lime itself carries off a certain quantity of heat, in the ordinary flame kiln. This quantity amounts to 0.22 B. T. U. per lb. of lime per degree of temperature, or about 450 B. T. U. per lb. of lime.

One pound of good coal will liberate approximately 13,000 to 14,000 B. t. u. If we could transfer all of this heat in the coal directly and without loss to the limestone, one pound of coal would burn approximately 8.95 to 9.65 lbs. of lime. Unfortunately, however, we cannot do this and there are appreciable losses, as explained above.

The actual results obtained vary considerably at different plants, but the following may be said to represent good practice in lime burning, or about 3.5 lbs. of lime per pound of coal:

	Per cent
Heat carried off by products of combustion	22
Heat carried off by lime	11
Heat lost by radiation	17
Heat lost by incomplete combustion	11
Total heat lost	61
Heat utilized	39
Total heat supplied	100

---

[1] Read at the Third Annual Convention of the National Lime Association, New York, N. Y., June 17, 1921. Diagrams by courtesy of *Journal of Industrial and Engineering Chemistry.*

[2] One pound of carbon burned to carbon dioxide will produce 14,580 B. T. U.; one pound burned to carbon monoxide only 3,173 B. T. U.

In Fig. 1 is given diagrammatically the distribution of heat in lime burning.

To effect economies in lime burning we must eliminate these sources of loss.

The Flame Kiln

Let us take up first the flame kiln and the question of the general design of the shaft. The object here is to transfer the heat from the gases to the stone. In order to do this, we must present to the gases as much surface of stone as possible and bring the gases in contact with this surface as uniformly as possible.

Size of Stone.—Unquestionably, in theory, the best results would be obtained by having the stone in small pieces, because this would present a greater surface of stone to the gases. In practice, however, the small stone presents too great a resistance to the flow of gases, and hence it is probably not possible to improve present practice greatly in the matter of stone sizes. However, it should be remembered that by the use of induced draft (fans) we can overcome to some extent the resistance offered by small stone to the flow of gas. We should also bear in mind that a stone of uniform size, even if small, will offer less obstruction to the flow of gases than will a mixture of large pieces and spalls.

The Lines of the Kiln.—The diameter of the kiln is controlled very largely by the question of distance to which the hot gases from the fire box will penetrate into the kiln, and this depends to a considerable extent on the fuel and draft used. Our own preference has been for a kiln with an oval cross section at and above the fire box, with the lesser diameter along the center line of the fire boxes. Two sides of the kiln are straight down to the cooling cone, while the other two sides are drawn in slightly, as shown in Fig. 1. If drawn in too much—and with some stone if drawn in at all—the charge will stick and hang up in the kiln.

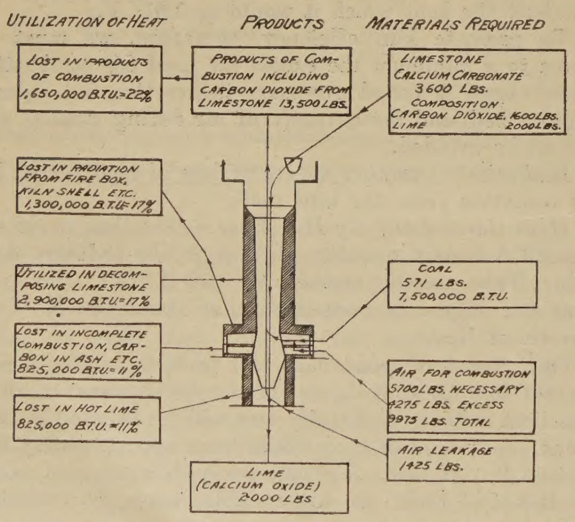

UTILIZATION OF HEAT
PRODUCTS
MATERIALS REQUIRED
LOST IN PRODUCTS OF COMBUSTION 1,650,000 B.T.U.=22%
PRODUCTS OF COMBUSTION INCLUDING CARBON DIOXIDE FROM LIMESTONE 13,500 LBS.
LIMESTONE CALCIUM CARBONATE 3600 LBS. COMPOSITION CARBON DIOXIDE 1600 LBS. LIME 2000 LBS.
LOST IN RADIATION FROM FIRE BOX, KILN SHELL ETC. 1,300,000 B.T.U.=17%
UTILIZED IN DECOMPOSING LIMESTONE 2,900,000 B.T.U.=17%
COAL 571 LBS. 7,500,000 B.T.U.
LOST IN INCOMPLETE COMBUSTION, CARBON IN ASH ETC. 825,000 B.T.U.=11%
AIR FOR COMBUSTION 5700 LBS. NECESSARY 4275 LBS. EXCESS 9975 LBS. TOTAL
LOST IN HOT LIME 825,000 B.T.U.=11%
AIR LEAKAGE 1425 LBS.
LIME (CALCIUM OXIDE) 2000 LBS

Fig. 1—Graffic Illustration of the Reactions in Lime Burning.

All are, of course, familiar with the fact that if a flat substance is brought in contact with the top of a flame, the latter will flatten out. When the gases from the fire box strike the stone the same thing happens and, consequently, they show a tendency to hug the sides of the kiln, hence the oval cross section.

The writer has generally preferred to flare the kiln out after leaving the burning zone, with the idea not only that there would be less chance for the charge to choke and arch, but also that as the lime spread into the enlarged area there would be a tendency for the charge to roll over and separate, and thus expose fresh surface to the flame. If drawn out through a cylinder of the same cross section it would probably merely sink down in a body.

Where we use a gas as a fuel we employ practically the same construction of kiln; that is, we draw the lining in above the gas ports and open it out again below these for the reason explained above. (See Fig. 2.)

Height of Shaft.—The height of the shaft above the fire boxes is important. It is pretty generally the practice to follow standard lines in the matter of the height. At the same time it is probable that a careful study of conditions would show that in the case of some stone very much higher kilns could be used with advantage than in the case of others. There is no question but that, within reason, the higher the kiln the better the economy which can be obtained, because a longer time is given the stone to absorb the heat from the gases. The height, however, is limited by the draft produced. Where natural draft is employed there is a limit to the height which is allowable, and 30 to 35 ft. above the fire box is generally considered ample. It is quite probable, however, that by the use of induced draft higher shafts could be employed.

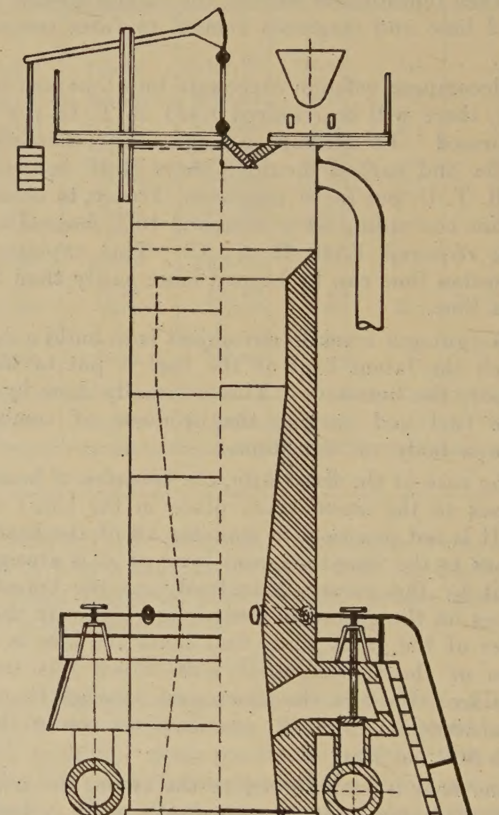


Fig. 2—Vertical Lime Kiln Arranged for Produce Gas.

Charging.—The charging arrangement shown on the top of the kiln illustrated in Fig. 2 will give satisfaction for closed-top kilns used with reduced draft. It is similar to those used on the smaller blast furnaces. It is quick acting and closes the opening tightly, preventing any cutting down of the draft due to air leakage here. If each kiln is provided with its own individual fan much better operation will be secured. This arrangement is particularly desirable where the fans can be directly connected to electric motors.

Stone Bin.—Practically all of the newer kilns employ a stone bin on top of the kiln. This is really part of the shaft but, as the temperature at this point is low, the bin is usually left unlined. There is no question about the advantages of the stone bin, and for practical purposes, the larger it is the better. The idea, of course, is always to have in the shaft of the kiln a body of stone sufficient to absorb the heat properly. If the stone b is made of the general design of the shaft, the gases probably pass up through the bin with some degree of uniformity, and it serves not only to hold the stone for the time when the kiln is not charged, but also as part of the shaft.

Cooling Cone.—Most of the better types of kiln are provided with a cooling cone. This is made of steel plate and is so placed that the lime is cooled entirely by radiation. The ideal arrangement for cooling the lime would unquestionably be one in which the air necessary for combustion passed up through the lime and cooled the latter, and thus recovered the heat carried off by the lime. In the case of coal-fired kilns, no practical method has been worked out by which this result can be achieved. In the case of gas-fired kilns, however, the air for the combustion is allowed to enter at the bottom of the cone, passing up through the lime and abstracting the heat from the latter.

It would probably be better to allow the shaft to project for 4 or 5 ft. below the fire boxes before the steel cone is placed on the latter. This would leave a considerable body of hot lime below the burning zone. No heat can be transferred from this hot lime to that being burned because radiation takes place only from a hotter body to a colder one, but there is always considerable air which enters the kiln where the lime is drawn and the hot body of lime below the arches would serve to heat this and prevent its cooling off the limestone in the burning zone. There is a mechanical objection to the use of such a form of cooler, however, in that it would necessitate raising the fire boxes about 6 or 7 ft. higher from the floor.

Quick-Acting Draw.—Attention has been called to the desirability of reducing to a minimum the excess air entering the kiln.

Unquestionably the largest thermal loss is in the excess air which enters the kiln at the time of discharging the lime and during the stoking of the fire. The former may be cut down to a minimum by the use of a very quickly acting draw on the cooling cone.

For the use on our kilns we have designed a very quickly acting draw which is shown in Fig. 3. The doors may be adjusted by means of lock nuts to an accurate fit with the bottom of the cone, and, as they are swung from beams resting in the concrete pedestal and not from the cone itself, they are not affected by the warping of the latter. The doors are opened and closed by a single push and pull on the operating levers. These latter are located outside of the kiln and permit the operator to stand away from the dust and heat when the lime is being drawn.

Allowing a hot body of lime to remain at all times between the cooling cone and the burning zone will also reduce the loss of heat due to the drawing of the lime, as we have said.

Hand Stokers.—We have recently tried hand stokers in place of the ordinary hand firing in order to cut down excess air used to burn the coal. The quantity of coal consumed in a single furnace of a limekiln is not large enough to warrant the installation of mechanical stokers such as are used on boilers and large furnaces. There are a number of hand stokers which have been successfully used for heating small metallurgical furnaces, and one of the most successful of these has been adapted to our type of limekiln. The result has been to increase greatly the capacity of the kiln, cut in half the labor necessary for stoking, and decrease materially the fuel consumption. We also find that with the kilns on which we have tried this stoker there is practically no core obtained, whereas on the same kilns without the stoker the core will probably run to about as much as 5 per cent of the lime. In view of the increased kiln output obtained by the use of stokers, this is one of the cheapest ways of increasing the capacity of a flame kiln lime plant.

Prevention of Heat Loss By Radiation.—Next to the excess air, the largest item of waste in lime burning is unquestionably due to radiation from the walls of the fire box and the kiln shell. It is, therefore, better practice to prevent this as much as possible. A new material which is both cheap and efficient is sil-o-cel. This can be obtained in blocks, but a more satisfactory form for the use in limekilns is the powder. It is quite the general practice to fill in between the brick and the shell with a thin layer of sand. An appreciable saving of fuel can be effected by the use of sil-ocel in place of this sand backing.

Structure of Kiln.—Referring to the structural features of the kiln, the most popular material for the shell is steel. There are some points, however, in favor of reinforced concrete. It is generally known that steel will radiate heat more rapidly than concrete. Some heat is therefore saved by the use of a concrete shell. The concrete shell is also more permanent, in that it does not require continual painting and is not subject to corrosion from the acids generated from the sulphur in the coal.

In some types of kiln the steel is run below the firing floor. This has seemed rather expensive construction, however, and we have built our kilns on concrete pedestals. Wooden forms are used and are moved from one kiln to the next during construction .

A weak point in the flame kiln has always been the arches. The writer has tried out several different kinds of brick, but his preference is now for specially made blocks of large dimensions and of exact key to fit the radius of the opening between the kiln and the fire box. We use a block approximately 17 x 11 x 15 x 18 in. and use one row of these. Fig 3 shows this block, which is much stronger than the standard 9 in. brick. They have a much larger key and wedge in more firmly. Owing to their weight, these blocks are not easily pushed out of place by a bar when poking down a hang-up. As they are specially made, the manufacturer will usually see that they are better burned and annealed and made of better clay mixtures than his standard brick.

The cooling cone has always been a weak spot in limekiln construction, and at some plants the advantage of obtaining cool lime has not proved sufficient to compensate for the frequency with which the cone has to be renewed. We have found that the life of the cone can be considerably increased by proper ventilation at the top, so that a current of air can pass around the cone at this point. As generally placed, the top of the cone is in a confined space and the air at this point is practically stagnant. By placing a few vents so that the air can pass up between the cone and the side of the kiln, a current of air can be made to pass around the cone at this point and reduce its temperature materially and increase its life. If desired, this air may be conducted into the fire box below the grate, but it is doubt-

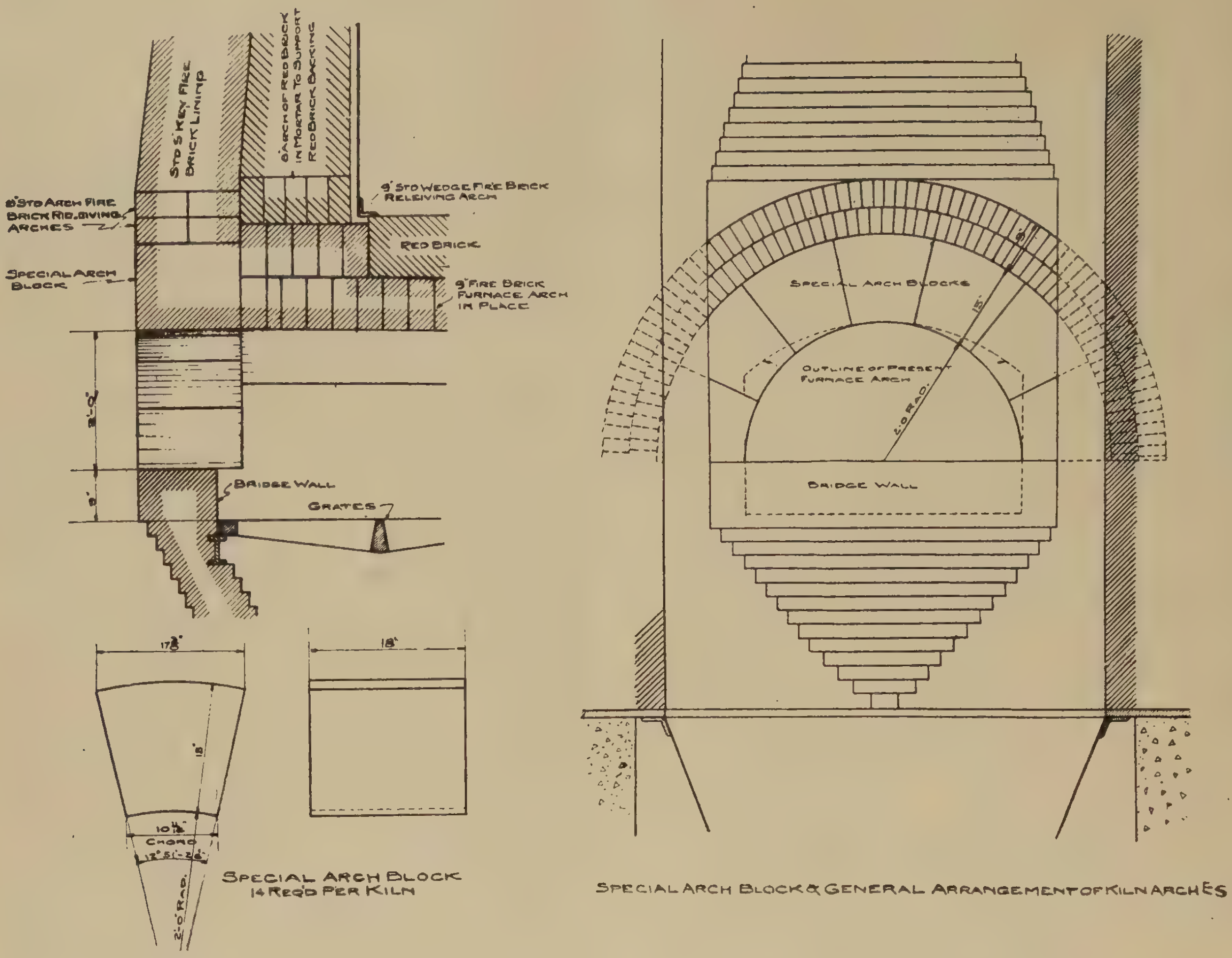

Std 5' Key Fire Brick Lining
6' Arch of Red Brick in Mortar to Support Red Brick Backing
9' Std Wedge Fire Brick Releiving Arch
8' Std Arch Fire Brick Releiving Arches
Red Brick
Special Arch Block
9' Fire Brick Furnace Arch in Place
3'-0"
9'
Bridge Wall
Grates
17¾"
18"
15"
10¾"
Chord
12" 5⅛'-2⅛"
2'-0" Rad.
Special Arch Block
14 Req'd Per Kiln
Special Arch Blocks
15"
Outline of Present Furnace Arch
2'-0" Rad.
Bridge Wall
Special Arch Block & General Arrangement of Kiln Arches

Fig. 3—Details of Kiln Construction.

ful whether any appreciable saving in fuel would be effected thereby.

On the last kilns which we have built, we have employed a water jacket around the upper part of the cone, the idea being not only to cool the lime but at the same time to protect the cone. We have made no effort to water-jacket the whole cone, but only a space of about a foot, as near the top of the cone as the jacket can be placed.

We have always made the platforms and walkways on top of our kilns of steel. For the floor plates we usually use perforated steel plates or a better and more rigid material—Irving's subway grating.

The Rotary Kiln

Turning our attention next to the rotary kiln, the losses here are practically the same as in the flame kiln. The losses due to radiation and to heat carried off by the products of combustion are greater than with shaft kilns, while the losses due to incomplete combustion and heat carried off by the lime are less. A complete general discussion of the rotary kiln lime plan and a comparison with flame and gas-fired kilns will be found in *Rock Products* of December 4, 1920.

Pulverized Coal.—The principles of heat transference are the same in rotary kilns as in shaft kilns. It is desirable to have a high initial flame temperature and to cut down to a minimum the excess air used in burning. Pulverized coal is much easier to regulate than producer gas and gives a higher flame temperature. Consequently it is to be preferred to producer gas when good coal low in ash can be secured. With pulverized coal, we can cut down the excess air used in burning to almost the exact amount required by theory, and we can also burn our fuel completely.

Pulverized coal is unquestionably a more efficient fuel for heating the rotary kiln than producer gas, and where complaints as to the fuel economy of the rotary kiln have come to our attention, we have usually found that the gas producer was at fault and the heating value of the gas supplied the kiln was low. It must be remembered that in gasifying coal some of its heating value is lost, so that the gas which is made from a ton of coal will not have the same number of heat units as this amount of coal itself. These losses in even the best gas producers are at least 10 per cent and often will run as high as 25 per cent, with perhaps 15 to 20 per cent as an average loss for mechanically stirred producers. In pulverizing coal, none of its thermal value is lost, so that we get the full heating value of the coal. In addition to this, pulverized coal can be burned completely, and the quantity of excess air necessary to do this is probably smaller than with any other fuel.

We must also remember that with pulverized coal we are feeding the kiln a uniform stream of fuel of the same heating value at all times, whereas with producer gas the quality of the fuel fluctuates with the condition of the producer.

By the use of pulverized coal, we introduce into the products of combustion in the kiln itself practically all of the heat units of the coal. The combustion is almost perfect, and there is no loss of heat to carbon in the ash or to radiation from the producer walls or gas piping.

Producer Gas.—The only producers which will give satisfaction and good fuel economy with either vertical or rotary limekilns are the automatically stoked, and preferably automatically fed, producers, as they can be made to furnish a constant supply of gas of uniform quality.

Where producers are used in order to improve the quality of the lime they shauld be set close to the kiln in order to reduce to a minimum the loss by radiation from the gas mains.

Factors Influencing Economy.—In a general way, it may be said that better results will be obtained by a large body of material moving slowly through the kiln than from a small body of stone moving rapidly. This means the kiln must not be pitched at too great an inclination.

If the diameter of the kiln is too large compared with the length, the fuel requirements will be high. Other things being equal, the longer the kiln the better fuel economy.

The size of stone burned influences the economy to some extent. As a general rule, better results can be obtained by screening out the dust from the coarse rock before burning. This dust also contains a large part of the dirt which finds its way into the quarry, so that its removal is of advantage in increasing the purity of the lime. In localities where water is abundant, there would be no objection to washing the limestone to free it from dirt, as the wet stone would not affect materially the operation of the kiln.

For the best production and economy, the stone should pass a screen with round perforations 2.5 in. in diameter, and should be retained on a screen with round perforations 0.25 in. in diameter.

Waste Gases.—In spite of the best efforts to transfer the heat from the gases to the stone, the exit gases will always contain considerable heat. The weight of exit gas will be smaller than with flame kilns because we can control the combustion better, but the temperature of the gases will be much higher because the conditions for heat transference are not so favorable.

The waste gases usually leave the kiln at about 1300° F., and hence contain a considerable part of the heat liberated by the burning fuel. This heat can be successfully utilized in boilers, as has been done in the cement industry, where an efficiency of 70 per cent has been obtained. The weight of gases usually amounts to between 6500 and 7500 lbs. per ton of lime produced. The heat in these gases will, therefore, be approximately 2,275,000 B. T. U. or the equivalent of 165 lbs. of coal. Of this waste heat, 70% has been successfully utilized by waste-heat boilers, or about 1,500,000 B. T. U. per ton of lime produced. This is equivalent to 1550 lbs. of steam at a temperature of 212 degrees F., or 45 boiler horse power hours. A kiln burning 4 tons of lime per hour, therefore, would be good for about 180 h. p. Most lime plants are operated in connection with crushing plants, or mills for grinding lime, pulverizing limestone, or hydrating lime, so that this power can generally be utilized. The kiln and its accessories will not require more than one-third of this, leaving about 120 h. p. for outside uses.

When power is required for other purposes in the works, therefore the installation of waste heat boilers and a crediting of the coal which would otherwise be required to generate this power to the kiln, will greatly increase the efficiency of the rotary kiln.

Rotary Cooler.—By the use of a rotary cooler, properly set, the heat carried out of the kiln by the lime can be recovered. The cooler should be placed so that the hot air will pass into the kiln. Thus the cooler will serve to pre-heat the air for combustion. The cooler should be provided with Z-bars or angle-irons which serve as lifters, carrying the material up and dropping it through the current of air passing through and so adding to the efficiency of the apparatus (and incidently also to the dust loss). The cooler may be divided longitudinally into four compartments which serve the same purpose. If dust proves too great the Z-bars may be removed from the latter form of cooler without too great a loss of efficiency.

As has been said, the radiation loss is quite large from a rotary kiln, but this can be reduced materially by the employment of a lining of sil-ocel blocks between the regular fire brick lining and the steel shell.

Chemical Control in Fuel Economy.—The completeness of combustion can always be determined by an analysis of the waste gases of the kiln whether it be gas or grate-fired, and the temperature of these gases will show how well the heat has been transferred to the stone. Pyrometers in the walls of the kiln, properly protected, will show the conditions and rate of burning also. Neither the pyrometer nor the gas analyzer requires trained chemists. Any intelligent workman can be broken in to use both, and even to interpret the results in terms of kiln efficiency. The latter, so far as the exit gases are concerned, is summed up in three phrases—low carbon monoxide, high carbon dioxide, and low temperature.

Factors Governing Color of Portland Cement

There are four factors which influence the color of portland cement, viz., the proportion of iron the cement contains, the type of kiln in which it was calcined, the fuel used to calcine it, and the degree of calcination, says *Concrete and Constructional Engineering*.

Dealing with these in order, the iron in cement is, of course, derived from the raw materials used in its production. A cement containing about ½% or less of iron oxide will be white, and with increasing proportions of iron oxide up to 5%, which is about the maximum in commercial cements, the cement passes from light gray to dark gray with a tinge of brown. Iron oxide has no influence on quality, so that the light gray color due to lack of iron does not imply inferior quality, nor does the dark color denote good quality.

There are two principal types of kiln in which cement is calcined, viz., rotary kilns, where the material is heated with a flame produced from powdered coal and in which the material does not come into contact with the fuel; and fixed kilns, into which the raw material and fuel are loaded together and come into intimate contact. The contact between material and fuel appears to have a considerable influence on the color of the cement, because identical raw materials fed into rotary and fixed kilns, respectively, will produce dark colored cement in the former case and light colored in the latter case, although at the same time there would be no essential difference in the quality of the two cements. Here again, then, color does not indicate the quality of cement.

It is the practice of some cement manufacturers to use anthracite fuel for calcination in rotary kilns, and where this is done the resulting cement is frequently brown in color. This characteristic is confined to the dry cement, the color of the set cement being normal. Numerous tests of such brown cement go to show that the quality is in no way affected by the anthracite fuel and the brown color it produces.

Rationale of the Burning of Portland Cement Clinker

By C. E. Burgoon

The writer has had occasion to review Mr. Rapier R. Coghlan's article on the Rationale of the Burning of Portland Cement Clinker, which appeared in the March, 1920, issue of Concrete and cannot check his computations nor agree to his explanations and conclusions. The following paragraph appears to be misleading and is subject to criticism:

> "We now have the heat of reaction at 60° plus the heat in CO_2 and clinker minus the heat in the reagents, CaO, MgO and clay, is equal to the heat required to bring about the combination of 364,606 B. T. U. + 365,618 B. T. U. — 243,550 B. T. U. = 486,674 B. T. U. Or, if we consider all of the reagents to be in the oxide form, we would have the heat in the reagents equal to 250,509 B. T. U., instead of 243,550 B. T. U., which would make the heat requirements 479,715 B. T. U. The net heat reaction of the silicates and aluminates at 60° is 70,496 B. T. U., leaves 409,210 B. T. U. per barrel of clinker."

The expression "Heat required to bring about the combination," is misleading. What combination is meant? As used, it covers the heat of decomposition of the carbonates, plus the sensible heat of the carbon dioxide from 0° F. to 1,800° F., plus the sensible heat of the clinker from 0° F. to 2,400° F., and minus the sensible heat of the calcined mix (not fused) from 0° F. to 2,400° F., or 364,606+107,440+258,178 — 243,550 = 486,674 B. T. U. In this equation it appears to be assumed that the clay of the calcined mix is a chemical compound. If the component parts of the clay are in the form of oxides, the sensible heat of the calcined mix will be 250,509 B. T. U., instead of 243,550 B. T. U., making the *combination heat* 479,715 B. T. U., instead of 486,674 B. T. U.

In making a *heat balance*, all the heat in the fuel must be accounted for, and in a cement kiln the heat is consumed by chemical changes in the mix or discharged from the kiln in the kiln gases, clinker and radiation, convection and conduction. The heat consumed by the chemical changes in the mix is the heat of decomposition of the carbonates minus the heat of formation of the silicates and aluminates, 364,606 — 70,496 = 294,110 B. T. U. An error was made in calculating the heat carried off in the kiln gases, and the quantity should be 565,550 B. T. U., instead of 511,517 B. T. U. The heat carried off by the clinker is very hard to determine, therefore no attempt has been made to check the amount given. Radiation is derived by differences; therefore, its correctness depends on the other items entering the heat balance. The following tabulation gives the heat balance as it appears in the above article and as corrected—temperatures of kiln gases and clinker, 1,300° F. and 1,800° F., respectively:

Item	Per Article		Corrected	
Heat supplied by fuel, B.T.U.	1,400,000	100.0%	1,400,000	100.0%
Heat to form clinker, B. T. U.	409 219	29.2%	294,110	21.0%
Heat in kiln gases, B. T. U.	511,517	36.5	565,550	40.4
Heat in clinker, B. T. U.	177,089	12.2	177,089	12.6
Heat in excess air, B. T. U.	132,804	9.5	......	....
Radiation, etc., B. T. U.	169,371	12.6	363,251	26.0

The item "Heat in excess air, B. T. U., 132,804," in the heat balance of the article is omitted in the corrected heat balance because it is the heat required to raise the excess air from 1,300° to 2,600° F. While the excess air would be heated to the temperature of the combustion zone, the heat above the temperature of the gases leaving the kiln, 1,300° F., would be consumed in the kiln; therefore, would not be a part of the heat balance.

The above article was referred to by a critic of a recent article on a similar subject; and the critic was of the opinion that the subject matter of the recent article is covered by the above article. Therefore, the publication of the recent article would be a repetition of what is already in print. The above evidently proves that the article in question contains serious mistakes, and the correction should be given to the industry.

Cement Trade in Kingston District

By Irvin D. Foos

The cement trade in the Kingston consular district, Ontario, Canada, according to the report of an investigation made by Consul Felix S. Johnson, submitted to the Department of Commerce, is almost entirely Canadian. The price paid at the end of 1921 was $3.75 per barrel of four bags of 87½ lbs. each, delivered Kingston, with a rebate of 80c on the return of the bags. These facts will give the American manufacturer an idea of the price at which he must sell in Canada to compete with the domestic cement.

Manufacturers in this country should also take into consideration that the duty on cement imported from the United States is 8c per 100 lbs.; cotton bags, 10c each; jute bags, 5c each; and paper, 2½c each. Besides this, there is a sales tax of 2½% imposed by the Canadian government on the wholesaler or importer and 4% on the retailer or consumer. The rate of exchange is adverse to American sales, with a premium of 10% now on the dollar.

Greater activity in construction work in the province of Ontario, and a greater demand for cement is promised with the advent of Spring. Consul Johnson states that present prices for cement are controlled by one syndicate throughout Canada, that has works extending from Winnipeg east to the province of Nova Scotia. The Department of Commerce has advised that interested manufacturers of cement in the United States should communicate with Consul Johnson at Kingston for a full description of local conditions.

Portland Cement Prices in 1921

Preliminary estimates made by the United States Geological Survey, from reports of representative producers of portland cement, show that the average factory price per barrel of portland cement, excluding cost of container, in the United States in 1921 was approximately $1.87.

The prices by districts were as follows:

District	Average Factory Price per bbl. in 1921
Eastern Pennsylvania and New Jersey	$1.72
New York	1.90
Michigan and northeastern Indiana	1.85
Illinois and remainder of Indiana	1.68
Western Pennsylvania and Ohio	1.73
Maryland, Kentucky, Virginia and West Virginia	1.83
Alabama, Tennessee, and Georgia	1.94
Iowa, Minnesota, and Missouri	1.77
Kansas, Nebraska, Oklahoma, and Texas	2.15
Colorado and Utah	2.33
California	2.35
Washington, Montana, and Oregon	2.51

The average net factory price received per barrel for the whole country in 1920, as shown by reports received from all producers, was $2.02.

Dust Collecting Systems for the Cement Industry

By W. G. Clark
President, Clark Dust Collecting Co.

Among other lessons that the late war taught us is the conservation of waste. Conserving products in all kinds of industries means getting the plant as nearly 100% efficient as possible. In the cement industry there is a great deal of waste in the form of pulverized material, both in the raw and finishing end, as well as in the powdered coal departments.

Many of the cement mills are learning the lesson that it is foolish to spend millions of dollars for high class pulverizing and grinding machinery to reduce their product into a powder and then allow a certain percentage of this powder to waste away. Every ton that is pulverized represents so much power, and so much investment, in the equipment used for pulverizing. The finer the material is, the better product you will have; therefore, the best part of the cement product is wasted away wherever the condition of fogging out in the atmosphere and around in the country is concerned. It also increases the wear and tear on the machinery, and makes an unsanitary condition in the plant that must be taken care of to insure the health of the employees and also to secure from the employees an honest day's work.

At the present time we note a great deal of attention is given to the question of dust recovery. There is an immense waste in some cases in the stacks from the kilns and also the stacks from the waste heat boilers. There are two systems for this purpose that are practical, viz., the Cottrell, or electrical system, and the proper designed cyclone collector. The latter is very much cheaper, and with the proper designed collector to handle the cubic feet of gases to the best advantage, a higher recovery can be secured.

We know of one case where 85% of the dust is reclaimed which formerly blew all over the country and wasted an amount of material which ran into hundreds of tons a year.

A dust system on tube mills is sometimes very helpful and proves a good paying investment. On dryers also, working on clay, limestone and coal, a big saving can be assured with the proper designed system for this purpose. On the raw end there is not a great deal of dust as a rule present, but the writer has found that it pays even in this department to get after the dust. One of the most economical places to apply a good dust collecting system in a cement plant is in the coal grinding department. The loss there soon runs into a great many dollars.

Therefore, generally speaking, we do not hesitate to state that a good dust collecting system in any department of a cement mill is a good investment for all concerned. Cement dust as a rule is of a cutting or abrasive nature, and is very injurious to belts and bearings. The right equipment to use on raw and finished product is the all-metal system, consisting of the proper size fan, adjustable air separator, and proper designed cyclone.

On powdered coal, and in some cases in the packing departments, we advocate and recommend the suction filter system, which is known as a 100% efficiency system. With the suction filter in use, we collect 99½%, which in dust collecting practice is considered perfect. A cyclone designed to catch sawdust and shavings will not collect cement dust in the best manner. It requires a different designed machine.

To collect coal dust we recommend the greatest care in designing the system to reduce as far as possible any chance of damage by explosion or fire. The Clark Safety System will reduce the damage of fire and explosion to the minimum. This is a system with safety blow-out pockets installed along the air line just for this purpose.

There is no question but what a successful and practical dust collecting system can be installed on any problem that will arise in any department of a cement mill. This equipment should not be selected on the advice of some blow-pipe concern, whose main business is installing sawdust and shaving jobs. This is an entire different proposition from valuable dust, such as appears in a cement mill. It requires certain engineering and planning of an expert dust collecting man to decide the size and kind of a dust collecting equipment to obtain the highest results. There are men that make this a business. They are known as dust collecting engineers, and it is far better to employ such men as this than one whose experience is limited to the A-B-C of dust collecting such as sawdust and shavings.

Cement Not Affected by Cyanide Solution

By E. J. Ochs

The following results of tests of the action of a cyanide solution on cement will be of interest to the mining industry:

	7 da.	28 da.	3 mo.	6 mo.	9 mo.	1 yr.	1½ yrs.
Sands (1-3) standard......	328	478	503	481	448	458	472
Sands (1-3) mix water; tap water but stored in .25% KCn solution	300	420	457	445	463	410	435
Sands (1-3) mix water .25% KCn solution, stored in .25 KCn solution	308	427	445	438	432	418	440

It will be noticed that there is practically no action on the briquettes, and the solution used is the upper limit of ordinary mining practice.

Substitutes for Cement

The high cost of portland cement on the European continent has led to innumerable substitutes, none of which have proved to be really satisfactory, according to *Tonindustrie Zeitung*. It is true some samples of hydraulic lime resemble portland cement so closely that they might form an efficient substitute, but unfortunately no reliance can be placed on successive deliveries of hydraulic lime, so that material cannot really be compared with portland cement.

Even more risky are the numerous substances which have been dignified with a name, such as Cementin, Silikalite, etc., because the name may convey the idea that the material has a special value, when, in reality, it may be hydraulic lime, possibly with some slight additions of small technical value.

The essential feature about portland cement is that its manufacture is controlled throughout by scientific tests, which, if acted upon, ensure its constant composition and properties, while substitutes—no matter how pompous their names—are not made under such careful control, and their behavior when in use is therefore more uncertain. In some cases the differences are so large as to make their employment risky or even dangerous. —*Tonindustrie-Zeitung.*

Gearless Crusher

An innovation in gyratory crusher design and construction is embodied in the Kennedy[1] Gearless Standard crusher. This crusher, without gears, and power applied directly to the eccentric, has been used during the past few years for fine crushing, and the satisfaction which it gave induced the company to embody the principle in a crusher of larger size. With the changes necessary for the application of the principle to very heavy machines, the crusher is simplified, its wearing parts are reduced and power requirements are diminished.

The crusher is shown in the accompanying illustration. It embodies the Kennedy ball-joint eccentric, which is designed to maintain perfect alignment of the main shaft and its bearing in the eccentric, eliminate the possibility of cramping or binding, and consequently prevent heating, high power consumption, rapid wear and loss of eccentricity. The machine has the same highly arched spider, permitting the passage of any stone that will enter the machine, the same spider ring clear of the top of the concaves, preventing breakage through expansion of the concave; the dust collars and the same general design and construction that characterizes the rest of the Kennedy line.

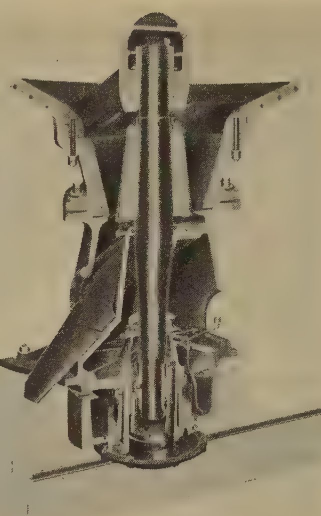
In addition to these features, the direct drive with its advantages is now embodied. The bottom plate sleeve acts as a support for the packed lower dust collar, and as this sleeve does not revolve, the wear on the collar is reduced to a minimum. This bottom plate sleeve acts also as a support in which the eccentric sleeve and ball are contained and for supporting the driving dogs. It also forms a journal for the driving pulley, which is equipped with ball bearings, reducing the friction to the lowest factor known to mechanical science. The bottom plate sleeve is shouldered on the inside to prevent the eccentric sleeve from moving upward. At the bottom it has a groove and shoulder for receiving the bayonet lock that supports the ball race and pulley.

The eccentric sleeve is made in two parts and is joined by bolts passing through at top and bottom. It has a pocket on the thick side for receiving the locking pin that connects the ball and socket bearing to the eccentric sleeve. This pin is flattened on the sides for providing ample bearing in the pocket, preventing wear. At the bottom, where the eccentric is joined together, it forms a male driving dog for fitting into the female seat.

The driving power is applied through a universal device that eliminates all friction and side strain due to the driving of the eccentric and relieves that grinding and side thrust common to all gyratory crushers. The thrust due to pressure against the eccentric is delivered to the eccentric sleeve at the middle of the ball, and thus the eccentric sleeve floats without pressure from top to bottom.

The pulley is supported by the bayonet lock method, aand is keyed in position. The eccentric is driven by a double male and female connection cast integral with the bottom plate. The bottom plate is bolted to the pulley and the joint is packed to prevent oil leakage. When the pulley turns, both the bottom plate and driving dog move, turning the eccentric directly, eliminating all pull and side thrust on the eccentric.

An important improvement is made in the design of the bottom shell. The base is made square so that stone may be spouted in any direction. This enables the operator to set the machine in any position without having to predetermine whether it shall be right hand, left hand or standard, as has formerly been necessary. Thus the crusher may be driven from a line shaft by belt or rope drive, universal rope sheaves or pulley for belt drives being supplied for leading belt or ropes from pulley or motor to the crusher. The drive pulley can be on the same horizontal plane or above or below the crusher, as desired. These features enable the crusher to be installed in any kind of position without difficulty.



The Kennedy Gearless Standard Crusher

---

[1] Kennedy-Van Saun Mfg. & Eng. Corp., New York City.

Shaft and Rotary Kilns Compared

In discussing the respective merits of shaft and rotary kilns, *Concrete and Constructional Engineering,* from which the following is abstractd, cites that the advantages of the shaft kiln are its low first cost, low fuel consumption, and its easily ground product, while its disadvantages have been high labor cost, tendency to under burning, and its dependence on the dry process.

The devices for mechanical feeding and discharging of shaft kilns that are being developed bid fair to remove the disadvantage of high labor cost hitherto connected with this type of kiln, and there is no doubt that if shaft kilns could be worked in conjunction with the wet process without undue complications, the cost of cement manufacture would be appreciably reduced. Under present conditions the shaft kiln must be fed with solid raw material, and this necessity demands, for all practical purposes, the adoption of the dry process, which adds considerably to the cost when soft raw materials, which could otherwise be washed, are used. If the slurry from the wet process be dried to the solid state, the cost is high and nullifies the fuel economy of the shaft kiln itself. Various mechanical means of removing the excess water from slurry to form a solid "pug," such as filter presses, rotary filters and centrifugal separation, have been considered, and none has commended itself to cement manufacturers owing usually to some feature of high labor, capital or depreciation costs. The field thus still remains open for the invention of a cheap means of producing a solid material from slurry.

The possibility of using kilns of the blast furnace type for producing a fused clinker was a favorite subject of discussion with the late Bertram Blount, and although this is an attractive idea, it is very far from practical attainment.

Coming to the respective merits of tube mills and centrifugal grinders, it is generally agreed that the latter are economical in power, but without the merit of simplicity possessed by tube mills. Simplicity of plant is being further extended by the adoption of the compound tube mill, but to what extent this simplicity is obtained at the expense of power is a subject still requiring investigation.

High Alumina Fused Cement

By E. Candlot[1]

Until quite recently it has been held that the limits of cement constitution were known within quite definite limits; the silica should be from 2½ to 3 times as much as the alumina, by weight; and the lime should be from 2 to 2½ times as much as the silica and alumina combined. If the alumina rose above these ratios, or if the lime fell below them, we obtained either an inert mass or a very quick-setting product.

It is to M. Bied, who from 1908 onward has attacked this problem, that the credit is due for proof that a valuable commercial product—the fused high-alumina cement or *ciment fondu* can be made, outside the old limits of composition, by fusion in the blast-furnace or in the electric furnace. And it is due to the persistence of M. Bied and the enterprise of French cement-makers that the new discoveries have been already made the basis of a growing commercial production.

We know that four lime aluminates exist: $5\,Al_2O_3,3\,CaO$; Al_2O_3,CaO; $3Al_2O_3,5\,CaO$; and $Al_2O_3,3\,CaO$. Of these the third named is the most fusible. Now if we commence with chemically pure materials and form these aluminates, either by clinkering or by fusion, we get products which have quick hardening, but very slow or little gain in strength after the initial hardening. But if we replace pure alumina by a commercial bauxite, the small amount of silica and iron oxide so introduced give a new series of products with important technical properties. They are not only quick-hardening, but they gain strength after hardening, like normal portlands, and they are specially resistant to chemical attack, from sea-water or otherwise.

In practice, having bauxites ranging from 5% to 20% silica and 45% to 60% alumina, we have made products from mixtures ranging from 100 bauxite and 50 limestone to 100 bauxite and 160 limestone.

This can be done by means of simple clinkering, in an ordinary rotary kiln. But the clinkering range of high-alumina mixtures is so narrow that commercially it is very difficult to get a good product in this manner; usually the result is to either underburn it or to fuse it to the walls of the rotary. In a 235 ft. rotary at the Lafarge mill one of these alumina mixes gave only 100 to 120 tons a day of a cement which was not strikingly good.

On this account M. Bied took up work with a water-cooled blast furnace, and for some years past the Societe Pavin de Lafarge has been making *ciment fondu* in this manner at one of the plants at Le Teil. The blast furnace is run with hot blast, and continuous flow of the product; in order to handle the iron which is reduced from the impure bauxite the coke consumption is higher than necessary for simple fusion of the mix. Unless we find some way of utilizing the excess heat the cost of this process, with coke at its high French prices, will be greater than if it be carried on in the electric furnace.[2] The electric process is actually in commercial use at Argentiere in the department of Haute Alpes, by the Societe Alais Froges.

The properties of ciment fondu are now well known; it is perfectly indecomposable in sea-water, or in sulphate waters; it sets normally and hardens very rapidly.

For thirty years I have worked on this first problem, and have shown that resistance to the action of sea-water, so far as composition of the cement is concerned, can be secured either by (1) keeping the alumina low, as in the high-iron portlands; or by (2) keeping the hydraulic index high. This latter can be done only by carrying very high alumina, as in the *ciment fondu.*

Whatever the explanation, the long experiences that we have now had with the fused cement have shown that its resistance to sea-water action is perfect. Not only in the laboratory, but in the extensive practical use made of it by the Paris-Lyons-Mediterranée railroad between Nice and Comi, the results have been satisfactory. The *ciment fondu* therefore resolves all questions as to concrete construction either in salt water or in alkaline soils.

Its hardening properties are equally valuable from a commercial and technical standpoint. A roadway constructed with it at Le Teil on Saturday evening carried a five-ton tractor Monday morning. Its use as artillery mountings during the war is of course well known in France and Germany at least. A cement which will set normally, like an ordinary portland, but will harden very rapidly, has of course very obvious commercial possibilities.

Freight Rates on Coal Affect Building Material Industries

Expenditures for fuel and power constitute 21.6% of the total cost of production of brick and tile, terra cotta and fire clay products, and 55.6% of the total cost of materials going into the manufacture of these products, according to statistics presented before the Interstate Commerce Commission recently in connection with its investigation into transportation charges. The coal producers stated that the total cost of production of these products per annum was $110,039,370 in 1920, of which $42,723,178 represents the cost of materials, while expenditures for fuel and rent of power total $23,753,969.

Lime

Total cost of the production of lime was placed at $15,113,390, of which $7,557,670 was the cost of materials and $3,534,377 was the cost of fuel and rent of power, representing 23.4% of the total cost of production and 46.8% of the cost of materials.

Cement

Cost of production of cement was given as $78,737,724, the total cost of materials as $51,986,798 and cost of fuel and rent of power at $20,271,662, or 25.7% of the total cost of production and 39% of the total cost of materials.

Similar figures, showing the percentage of total cost of production required for fuel and power, were given for other commodities by the coal producers, in an endeavor to convince the Commission that the freight rates on coal must be reduced because of the effect of the cost of coal upon other industries.

Buchanan Bulletins, Nos. 9, 10, 13, 14—C. G. Buchanan Co., Inc., 90 West St., New York City; each 8 x 10½ in.; Nos. 9, 10, 13 contain 16 pp.; Nos. 14, 20 pp. No. 9 lists type "B" crushers and parts, with much descriptive and illustrative matter. No. 10 gives the same for type "C" crushers. No. 13 covers crushing rolls and No. 14 gives information on magnetic separators.

---

[1] "*Le ciment fondu,*" par E. Candlot. Article in *Le Ciment,* November 1921, pp. 327-328. Translated and summarized by Edwin C. Eckel.

[2] See *Engineering News-Record,* October 6, 1921, for a discussion of fuel and output of the blast furnace process.—E. C. E.

Men and Mills

Notes from the Field

Seventy-five thousand tons of cement rock were loosed by a single blast in No. 3 quarry of the Coplay Cement Manufacturing Co., at West Coplay, Pa. The blast was the largest set off in the cement region for some time past. The rock would keep the mills at the company's plant in operation for two months at capacity production, but will last for five months at the rate the mills are now using rock. A similar blast, not quite as extensive, was set off a week previous.

Fifteen holes were drilled twenty feet back from the face of the quarry, each hole being twenty feet apart. They were 145 feet deep, and were filled with 25,000 pounds of dynamite.

A year of unusual success was reported by the Gilmore Portland Cement Corporation at its annual stockholders' meeting held Jan. 5. The meeting was attended by more than 100 of the stockholders from the different parts of Iowa besides a number from Minnesota and adjoining states. A review of the business for the year was given, officers elected for the ensuing year and some of the business policies of the company taken up and approved.

Following the stockholders' meeting the annual meeting of the board of directors was held at which an annual dividend of 7% was voted.

The reports of the officers of the company showed an unusually prosperous year. Additions to the plant in conformity with the plan to build at Gilmore City the second largest cement plant in Iowa were reported costing $126,000. The conduct of the business showed a profit for the year of more than $121,000, and a wonderful increase in trade territory which this mill is serving.

The production of the mill has been increased nearly 50% during the year over what it was the preceding period and the outlook for the coming year is much brighter than has heretofore existed for the company.

The officers of the company, who were unanimously re-elected, are as follows: President, M. J. Nicholson, Fort Dodge; vice-presidents, A. R. Baxter, Cedar Falls; L. H. VanAlstine, Gilmore City; T. M. Mair, Gilmore City; secretary-treasurer; H. S. VanAlstine, Gilmore City; general manager, Harvey W. Lamphere, and superintendent, E. W. Webster, were retained by the company.

The board of directors for the year are: Fred Spies, Graettinger; A. R. Baxter, Cedar Falls; O. A. Tenold, Calmar; S. E. Weitzell, Gowrie; L. H. VanAlstine, Gilmore City; H. S. Van Alstine, Gilmore City; M. J. Nicholson, Fort Dodge; O. M. Oleson, Fort Dodge; L. J. Clave, Ottosen; A. J. Case, Estherville; Albert Shindelar, Calmar; E. P. Barringer, Ruthven; T. A. Mair, Gilmore City.

The plant of the Newago Portland Cement Co. was shut down in December for the winter months, following the largest production year in its history, a total of 545,000 barrels of cement having been manufactured since April. A considerable number of men will be employed during the winter on repair work.

After producing more than $1,000,000 worth of cement in 1921, the Olympic Portland Cement company's big plant has closed for the year. The company is uncertain when it will resume operations, this depending upon the demand, which at present is indefinite.

During this year the company produced 430,000 barrels of cement, of which 90,000 barrels are still on hand. The company employed in 1921 an average of about 150 men and its payroll approximated $200,000.

Shipping during the last year was fair, the company reports. Most of its shipments were used in road construction.

International Cement Corporation has paid off the last of its bank loans, according to the *Boston Herald.* The company is therefore free of bank debt practically for the first time since organization. Last June bank loans totalled about $1,050,000, including the loans of the Knickerbocker Co., which at that time was being operated independently.

A group of students from a New York technical school visited and inspected the plant of the Coplay Cement Manufacturing Co. recently.

Repairmen were called out late in December to repair Mill F, of the Lehigh Portland Cement Co., at Ormond, in order to resume operations. The mill had been idle for a number of weeks.

Francis Danner, Northampton, Pa., had the misfortune of fracturing the right leg below the knee while at work for the Lawrence Portland Cement Co. at the quarry, commonly known as the Bonneville quarry.

The Americanization school opened in December in the Washington building, Northampton, for the winter season. The school is being conducted by the Lawrence Portland Cement Co. for the benefit of employees who desire to learn the English language, and wish to become citizens of the United States. The instructor is Clinton A. Bilheimer, the manual training teacher of the local high school. The local school authorities are co-operating with the Lawrence Cement Co. and are furnishing the room, fully equipped, to hold the classes.

Shortly after her parents died from burns in a fire which destroyed their home, Anna Elsie Roth, aged 11 years, was legally adopted by Mr. and Mrs. Warren W. Wolfe. Mr. Wolfe is superintendent of the Giant Portland Cement Co.

A number of train crews of the Ironton R. R. have been laid off because of the shutdown of cement mills in the Lehigh region. Several of the Lehigh Portland mills have closed although only a short supply of cement is on hand.

One man was killed and another seriously injured, when they were caught in a landslide in the quarry of the Pennsylvania Cement Co., near Bath, while they were engaged in stripping operations.

Leonardo Morello, Italian interpreter at the Lawrence Portland plant, and Miss Bessie Silvius, Northampton, were married Dec. 27, 1921.

H. T. Raisbeck, plant manager of the Atlas Portland Cement Co., and B. E. Miller, plant manager of the Atlas works at Hudson, N. Y., recently made a tour of the various plants in the valley.

At the annual meeting of the Cement Securities Co., held recently, the following directors were elected: Charles Boettcher, Claude K. Boettcher, Harry C. James, James Q. Newton, John H. Porter, M. D. Thatcher, and R. J. Morse.

The new board organized by electing the following officers: President, Charles Boettcher; vice-presidents, Claude K. Boettcher, Harry C. James, and R. J. Morse; treasurer, Harry C. James; secretary, R. J. Morse; assistant secretary, Carrie H. Morse.

Argument was heard recently in the equity suit of the Atlas Portland Cement Co. vs. L. Keller Brubaker and Margaret Armstrong, before Judge Shull at Stroudsburg. The action was brought by the cement company to compel the defendants to give it a deed for certain clay lands at Saylorsburg.

The allegation is that the defendants entered into an option for the sale of this land which the cement company accepted but which the defendants had never carried out. It was alleged that they had conveyed land to another company, the White Clay Products Co. Testimony in the case was taken some time ago.

The Bath Portland Cement Co. recently posted notices of a further 10% reduction in wages. The previous reduction was made in April 15, 1921, and amounted to 10%. This reduction comes despite the fact that a marked improvement in the cement market is reported. Nearly all of the plants of the Nazareth and Bath sections are in operation, and this has had its effect on realty transactions in that section. During January, there has been a big boom in property trading and purchasing, most of the homes being bought by those connected with the cement industry.

A basketball league has been formed by teams representing six cement mills in the vicinity of Nazareth, Pa. The companies represented are the Dexter, Hercules, Nazareth, Penn-Allen, Pennsylvania and Phoenix Portland Cement companies.

Employes of the Newago Portland Cement Co. were made happy and considerably richer when approximately $15,000 was distributed among them. The sum received by each employe represents a bonus of 8% on his wages for the year 1921, this being the same dividend as will be paid to the holders of common stock of the company.

In addition to the cash dividend received by each employe, an increase of $100 was made in insurance policies of less than $1,000 held by them and paid for by the company.

The distribution of the bonus checks during the last week before Christmas gave an added impetus to local holiday trade, and had the further effect of again bringing into relief the excellent spirit of co-operation and good feeling which exists between the big concern and the men who make the wheels go, a condition which reflects to the advantage of every citizen of Newago.

Allen Starner and a force of men from Bath, Pa., have been employed at the Beach Ithaca Cement plant, with which Morris Fortuin is connected, making a number of repairs to the Ithaca, N. Y. plant.

Charles A. Porter, superintendent of the Lawrence Portland Cement Co., Northampton, Pa., has been elected to the board of managers of the Engineers' Club of the Lehigh Valley.

The Peerless Portland Cement Co. of Union City closed manufacturing operations for the season on Dec. 29, following a highly successful season of ten months' duration. There has been no cessation of manufacturing during this entire period and the output is the largest in the history of the concern, which is one of the oldest in Michigan. The annual repairs and the installation of new machinery have been started and will continue until the reopening of the factory about the first of March. A number of notable improvements are to be made, among them the application of new methods which will increase the output of the plant about 30%. This is to be accomplished by improved air pressure in the burning rotaries and the reduction of moisture in the slurry.

More than 200 members of Chicago Chapter, American Association of Engineers, were guests of the Universal Portland Cement Co. at Buffington, Ind., recently. The trip to the Buffington plant was made in motor busses.

At Buffington the engineers were conducted through the plant by company officials, and were shown through the waste heat power plant by Superintendent H. B. Lundbohm, a member of the Chicago chapter.

The Penn Allen Cement Co., of Allentown, filed claim for $55,030.59, and the Nazareth Cement Co. a claim for $114,000, against the Pennsylvania Power & Light Co. as reparation, which may be affected by pending protests against rates.

The members of the congregation of the Ukranian Greek Orthodox Church of the Holy Virgin, of Northampton, are deeply grateful to the various cement companies throughout the cement region that contributed materials to the erection of their new church structure, costing $14,000.

A suit in equity to enjoin the Midwest Cement, Credit and Statistical Bureau from "keeping up an unlawful combination and conspiracy in restraint of interstate trade and commerce in cement," was filed in Federal Court October 24 by the government. Twenty-four firms are named as defendants, according to the *New York Journal of Commerce*. The defendants operate thirty mills in Pennsylvania, Ohio, Michigan, Indiana, Illinois, Iowa, Missouri, and Kentucky.

"Ninety per cent of the cement used in the Middle West is manufactured by the defendants," Assistant United States District Attorney Milroy said, "while their output is one-third of all the cement manufactured in the United States."

Among those named were the Newaygo Portland Cement Co., Grand Rapids, Mich.; Castalia Portland Cement Co., Pittsburgh; Crescent Portland Cement Co., Wampum, Pa.; The Diamond Portland Cement Co., Cleveland; Huron Portland Cement Co., Detroit; Indiana Portland Cement Co., Indianapolis; Kosmos Portland Cement Co., Louisville, Ky.; Michigan Portland Cement Co., Chelsea, Mich.; Peerless Portland Cement Co., Union City, Mich.; Peninsular Portland Cement Co., Cement City, Mich.; The Sandusky Cement Co. Cleveland; Wabash Portland Cement Co., Detroit; The Wellston Iron Furnace Co., Jackson, Ohio; Wolverine Portland Cement Co., Coldwater, Mich.; The Wyandotte Portland Cement Co., Detroit.

The bill states that the twenty-four defendants ship approximately 30,000,000 bbls. of cement annually.

Operating Under Difficulties

and even these two Brownings are setting economy records

George T. Jennings, American Sand and Gravel Co., Chicago, says:

"We are operating two Browning Cranes in our sand and gravel storage yards. These cranes are used only to unload gravel and sand from freight cars to hoppers. We do not have enough space to operate any other kind of equipment, and even if we had space it is a question whether any other equipment would operate as efficiently and cheaply as our Browning cranes. They are operating for a figure that we could not duplicate with any other equipment. When we need cranes in our other yards, we will surely install Brownings."

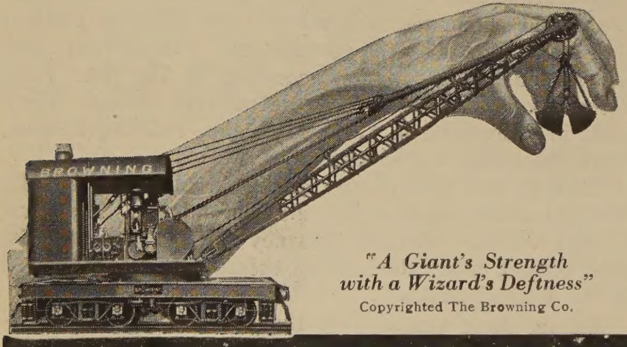
These two cranes, operating under difficult conditions, are *on just one job,* but they're saving money for the owners.

When you consider that a Browning also switches cars—saving demurrage—and is readily convertible to steam shovel uses and scores of other jobs you can figure on many other savings.

If you will write us briefly, describing your operations, we will tell you exactly what savings have been effected with Browning equipment by concerns with problems parallel to yours.

THE BROWNING COMPANY

Cleveland, Ohio, U. S. A.



"A Giant's Strength with a Wizard's Deftness"

Copyrighted The Browning Co.

BRANCHES:

NEW YORK
CHICAGO
PORTLAND
LOS ANGELES
BIRMINGHAM

WASHINGTON, D. C.
SEATTLE
SALT LAKE CITY
SAN FRANCISCO
MONTREAL

BROWNING

LOCOMOTIVE CRANES